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MILITARY ENGINEERING

VOLUME III—PART III

BAILEY BRIDGE—NORMAL USES

1944

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MILITARY ENGINEERING

Vol. III. Part III.

BAILEY BRIDGE—NORMAL USES

1944

INTRODUCTION

1. Object of the pamphlet

This pamphlet on the Bailey Bridging equipment contains details of design and method of construction for all normal uses of the fixed span and floating bridges up to and including Class 70. No details of construction involving the use of parts not normally carried by the Bridge Company R.A.S.C. are given. M.E. Vol. III, Part IV will contain details of these special uses of the equipment. It will be published in the form of pamphlets, each covering a different special use and issued when sufficient information is available.

This is an instructional book, but is laid out so that, as far as is possible, the answer to any problem concerning a particular type of construction can be found under one heading. The tables given contain information which is sufficiently accurate for all purposes in the field.

Nothing in this book alters the reconnaissance, transport, and protection problems that any bridging operation presents, and which are covered by existing publications.

2. General description of the use of the equipment

The Bailey equipment can be assembled quickly in different ways for various loads and spans of fixed or floating bridges. It is simple to erect and launch, all parts can be easily manhandled, and all fit into 3-ton lorries. A bridge strong enough to take the vital transport and support weapons can be put across early in the assault, and strengthened later *in situ*, if heavier loads are required.

The floating bridge is simply made up of fixed spans either from bank to pontoon raft, or from pontoon pier to pontoon pier ; much of the teaching for fixed span bridges will therefore apply equally to floating bridges.

BAILEY BRIDGE—FIXED SPANS

CHAPTER 1

OBJECT AND USES OF EQUIPMENT

SECTION 1—GENERAL DESCRIPTION

The bridge is of the " through " type, the roadway being carried between two main girders.

A main girder is formed from panels 10 ft. long pinned together end to end. The strength of the girder can be increased by adding extra panels alongside and on top of the original panels. The different arrangements of panels are known as trusses and storeys ; a girder made up of three panels alongside each other, and none on top, is known as " triple truss, single storey " while a girder made up of two panels alongside each other and one set of two on top is known as " double truss, double storey."

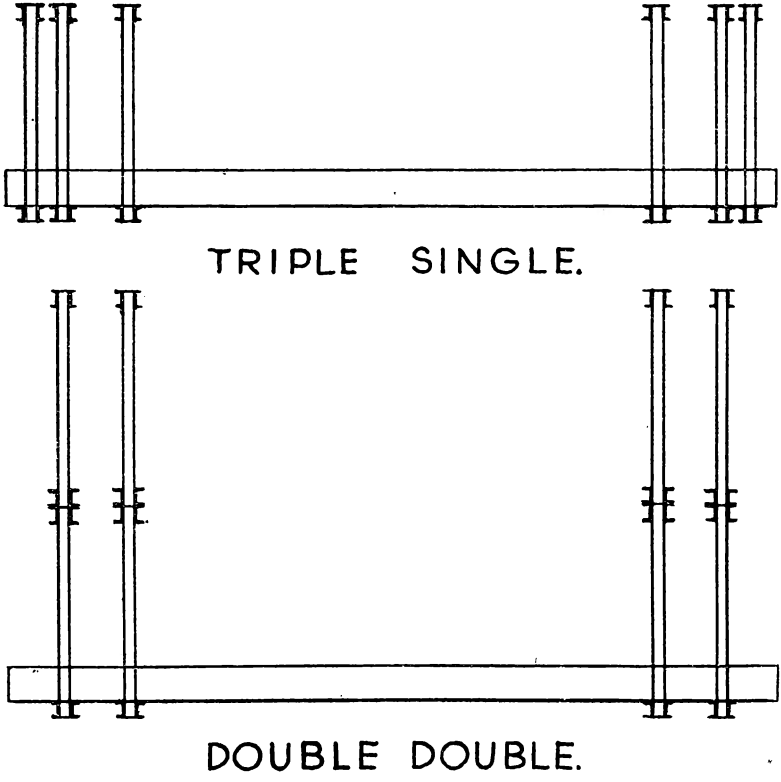


FIG. 1

The bridge is described according to the number of trusses and storeys which form its main girders. In all cases the number of trusses is given first followed by the number of storeys. " Single single " is the lightest combination possible, and " triple triple " is the heaviest. " Single double " and " single triple " must never be used, because they form unstable structures due to lack of lateral strength. There are therefore seven possible combinations of girders.

The distance between the inside edges of the inner trusses of the main girders is 12 ft. 4 ins. The second truss is placed 18 ins. centre to centre, outside the first truss. and the third truss 8½ ins. centre to centre outside the second.

The girders are connected crosswise by transoms. These are long R.S.Js. which rest on the bottom chord of the panel, and carry the roadway superstructure. They are tied to the panel chord by clamps, and fix the trusses in position at the distances apart given above. Across the transoms run the roadbearers, which for ease of construction have been welded together in groups of three to form stringers, and are 10 ft. long, the same length as a panel bay. Running across the stringers are placed the wooden chesses which form the deck of the bridge. Ribands are provided to guide traffic and to hold down the decking; the width of roadway between ribands being 10 ft. 9 ins.

Footwalks for pedestrian traffic, 2 ft. 6 ins. wide, fit outside the main girders of the bridge, and are carried on footwalk bearers which are secured to the ends of the transoms. The bridge is supported at each end of the span on bearings and baseplates, and ramps are provided to give ease of access to the deck of the bridge. This is 2 ft. 3¾ ins. above bottom of baseplate.

The bridge can be constructed between bankseats at different levels, but wherever possible the finished slope of the bridge should not exceed 1 in 30.

SECTION 2.—LOAD CARRYING CAPACITY

Table 1 shows the spans in feet over which the different load classes can be carried by the various types of bridge.

The following points should be carefully noted when considering the load carrying capacity of bridges :—

1. Packing

(*a*) For all loads over Class 24, THE END TRANSOM AT EACH END OF THE BRIDGES MUST BE PACKED AT ITS CENTRE POINT with the folding wedges provided, or with improvised timber packing. This method is necessary because the change of slope between the ramp and bridge deck, which occurs at the transom, causes tracked vehicles to rock about this point. Such rocking puts the full load on to the one transom supported only at its two ends, and produces an excessive load on the transom.

(*b*) FOR ALL LOADS IN EXCESS OF CLASS 40, EACH 10 FOOT RAMP SECTION MUST BE PACKED AT ITS MID SPAN POINT. It is designed to take only Class 40 loads over the clear span. An alternative method, using a 10 ft. level ramp bay and no packing, is illustrated at Plate XI.

2. Transoms

Up to and including Class 40 loads, *two* transoms are required per bay of bridge. Over Class 40, *four* transoms are required per bay.

3. Sag

A characteristic of the bridge is the natural sag due to the clearance in the pin holes, which has been left deliberately to facilitate assembly. This shows up particularly in the longer spans of single storey bridge, but no anxiety need be felt on this score.

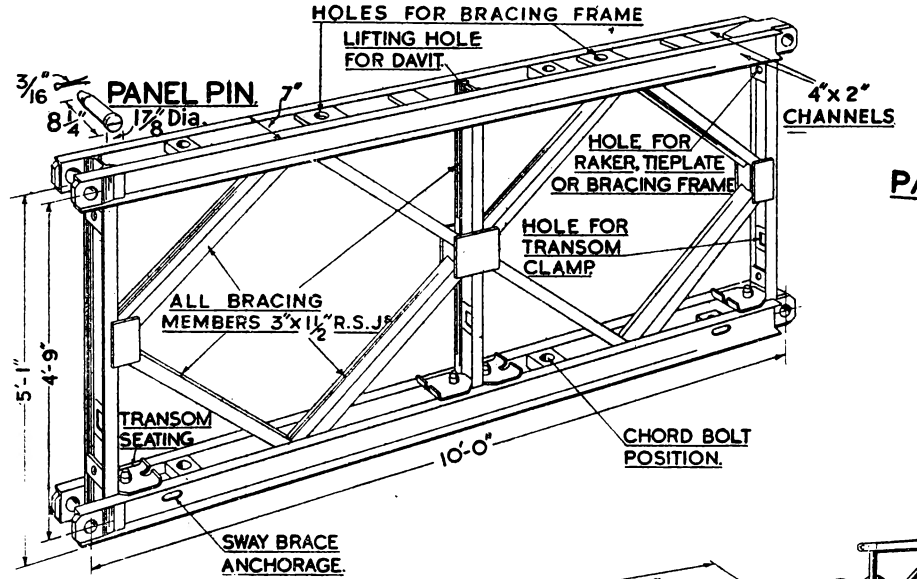
Nevertheless, it is better, if possible, to erect the longer span bridges in double storey construction rather than in single, even at the expense of slightly more material. This statement refers particularly to replacement L. of C. bridges, which are likely to be semi-permanent.

TABLE 1

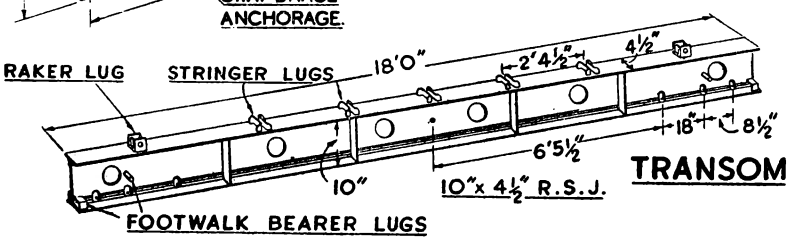
Bailey load class and spans

Load Class	Span in feet						
	SS	DS	TS	DD	TD	DT	TT
9	90	150*	170*	180*	200	230	240*
12	80	140*	160*	180*	190	220	230*
18	60	110	140	160	180	200	210*
24	60	110	140	150	170	200	210*
30	50	100	120	140	160	190	200*
40	30†	80	110	130	150	180	190
50		60	90	110	130*	160	180
60		50	80*	100	120*	130	160
70		40*	70*	90*	110*	120	150

* Subject to confirmation by test.
† Can be used up to 50 ft. span in emergency.

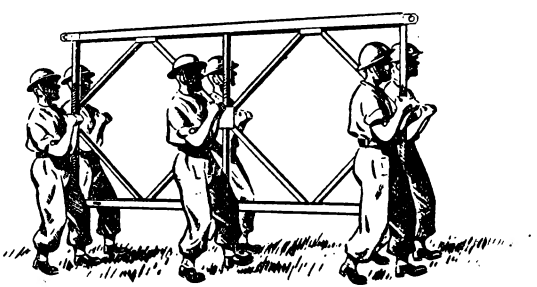


PANEL.



TRANSOM

Panel being carried



CHAPTER 2

DESCRIPTION OF BRIDGE PARTS

SECTION 3.—DESIGN AND PURPOSE OF EACH PART

The parts of the bridge are split up in this section according to their use, *i.e.* main bridge and decking members ; bracing members ; and end of bridge members. Dimensions of parts have in all cases been excluded from the text, but will be found on the accompanying drawings. The weights of individual parts given may vary slightly with different manufacturers. They are however sufficiently accurate for all field calculations.

1. Main bridge and decking members

(*a*) *Panel and panel pin.*—The panel is the basic member of the bridge. It is made up of top and bottom main chords with vertical and diagonal bracing, and is composed of high tensile structural steel. All joints are welded.

At one end of the panel the chords terminate in male lugs, and at the other end in female lugs. Joints between panels are made by engaging these lugs and inserting panel pins in the holes provided. The panel pin is formed of special alloy steel and is specially treated to resist rust. It is tapered at one end to facilitate insertion in the panel, and a hole is provided for a split pin. Parallel to the split pin hole, a groove is cut in the head of the pin, which must be horizontal when in position, since otherwise difficulty will be experienced in inserting the split pin. Pins are inserted from the inside on the first truss, and from the outside on the second and third.

There are holes in the top and bottom chords by which panels can be joined one above the other using CHORD BOLTS, thus forming double or triple storey bridges.

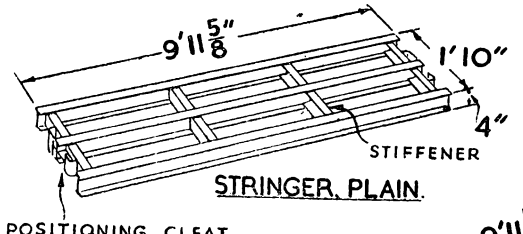
Four transom seatings, with a positioning dowel in the centre, are provided on the bottom chord, which also has the recesses into which the SWAY BRACE is pinned.

In the top chord and end verticals, holes are provided for fixing the BRACING FRAME ; the top hole in the end vertical also being used for fixing the RAKER and TIE PLATES.

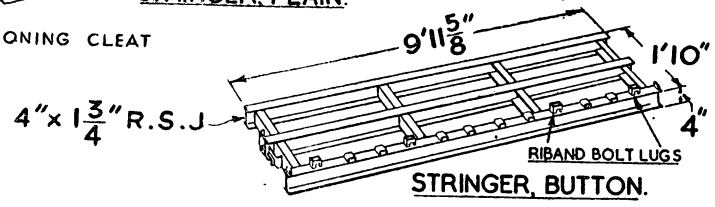
The weight of a panel is 570 lb. and it is carried by six men using carrying handles ; the pin weighs 6 lb.

(*b*) *Transoms.*—The transom is composed of an RSJ manufactured from high tensile steel. On its underside it has recessed dowel holes, three at each end, which correspond with the dowels on the panel seating. By means of these, the main girders of the bridge are fixed laterally. On its upper side, in the centre, are welded five positioning lugs for the STRINGERS, and at the outer ends, two lugs which locate the lower end of the raker.

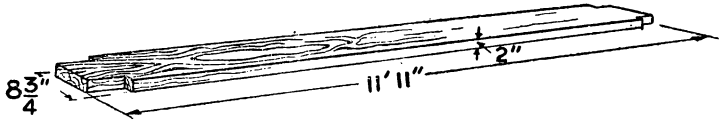
PLATE II



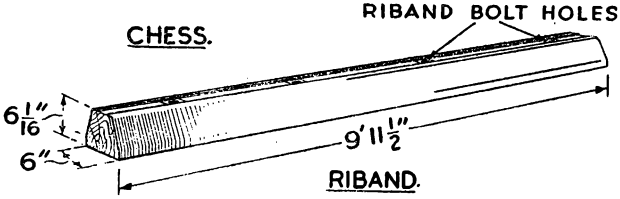
STRINGER, PLAIN.



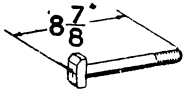
STRINGER, BUTTON.



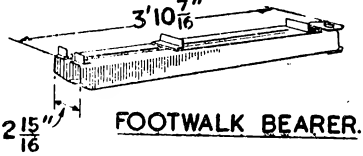
CHESS.



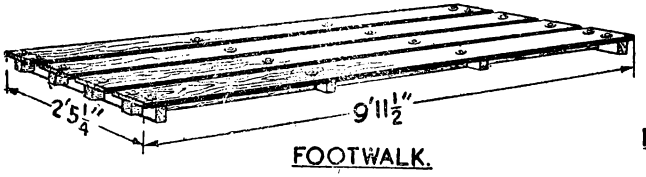
RIBAND.



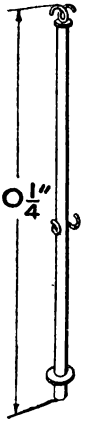
RIBAND BOLT. (3/4" B.S.W.S. NUT.)



FOOTWALK BEARER.



FOOTWALK.



FOOTWALK POST.

Footwalk bearers slide over the web of the transom and are fixed by one lug on the web and one lug on the bottom flange.

The transom weighs 445 lb. and is carried by six men.

(*c*) *Stringers, plain and button.*—The stringers form the support for the roadway between the transoms. They consist of three R.S.Js. welded into a frame, with stiffeners added for additional strength ; the whole assembly is of mild steel.

Stringers are positioned laterally by the lugs on the transom, and longitudinally by the positioning cleat on the stringer itself, which butts up against the transom lugs.

The button stringer is identical with the plain stringer except that it has on the outside joist twelve buttons for positioning the roadway CHESSES, four of which are slotted to take the " T " head of the RIBAND BOLTS.

A plain stringer weighs 183 lb. and a button stringer 190 lb. They are carried by two men.

(*d*) *Chesses.*—Chesses are of Grade III timber and form the wooden roadway of the bridge spanning across at right angles to the stringers. They are held down by the RIBANDS in between the buttons of the button stringer.

(*e*) *Ribands.*—Ribands are made of timber, and are sloped and faced with metal on both sides. They are laid down each side of the roadway and serve both to keep traffic central, and to hold down the decking. They are fixed down by the riband bolts, which are of the " T " head variety, and are locked into the button stringer by turning the " T " head through 90 degrees in the slotted button. The nut used for tightening is of similar type to those used for fastening bracing throughout the bridge.

2. Bracing members

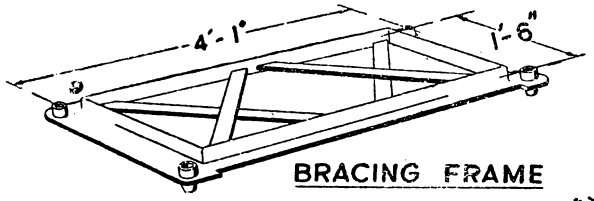
(*a*) *Raker.*—The raker is an R.S.J. made from high tensile steel. It connects the end of the transom to the top of the inner truss and gives the truss lateral stability. Hollow conical dowels are fitted at each end, which serve to draw the panels into correct alignment by engaging in holes in the panel and transom. One raker is used on each side of the bridge at every panel junction point. It is fastened by means of the BRACING BOLT. The raker weighs 18 lb.

(*b*) *Tie plate.*—A tie plate is flat steel plate with a hollow conical dowel at each end. It is held in position by bracing bolts.

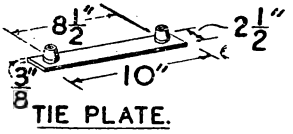
Its function is to secure the third truss to the second in triple truss bridges. It is used in the following positions :—

(i) In a triple truss single storey bridge, between the unoccupied raker holes in the panels at each joint. One tie plate is used on each side of the bridge at each joint, between the front panel verticals.

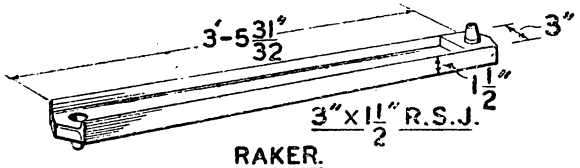
PLATE III



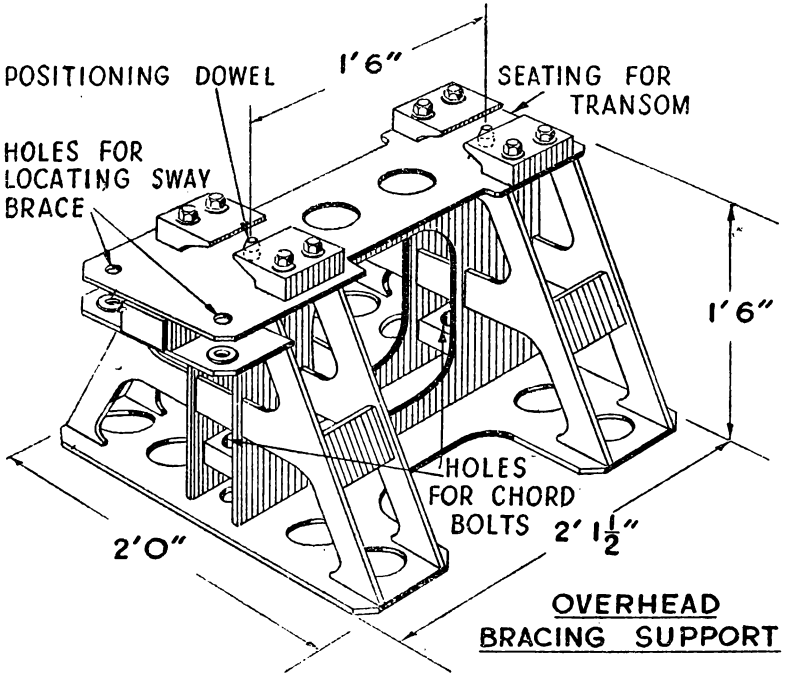
BRACING FRAME



TIE PLATE.



RAKER.



OVERHEAD BRACING SUPPORT

(ii) In a triple truss double storey bridge, in the same holes as in (i) above, and, in addition, in the corresponding holes in the upper storey, between the front panel verticals.

It is not always possible to use a tie plate on the end panels of the top storey. Sub-para. (iii) under bracing frames below, explains why.

A tie plate weighs 3 lb.

(*c*) *Bracing frame.*—A bracing frame is a light mild steel welded frame with a hollow conical dowel at each corner. It is used in two ways in order to brace double truss bridges together :—

(i) In a double truss single storey bridge, a bracing frame is bolted horizontally on top of the centre of each pair of panels.

(ii) In a double truss double storey bridge, a bracing frame is used in a similar position on top of the upper pair of panels, and one is used in addition vertically above each raker, on the rear verticals of each pair of panels.

(iii) In the end bay of double storey bridges a bracing frame is also used on the front panel verticals. A tie plate cannot therefore be used in this position.

A bracing frame weighs 40 lb.

(*d*) *Overhead bracing support.*—This is a box type unit of welded construction used for bracing the third storey of triple storey bridges. It rests on the inner and middle trusses, to which it is attached by chord bolts. These are inserted downwards through the holes in the support, and into the chord bolt holes of the panels.

The top flange of the support has positioning dowels for locating the transom, which is held in place by four removable clamps on the support. Under this flange are two sockets, which receive the ends of sway braces. The support must be placed on the girders with these sockets on the deck side of the inner truss.

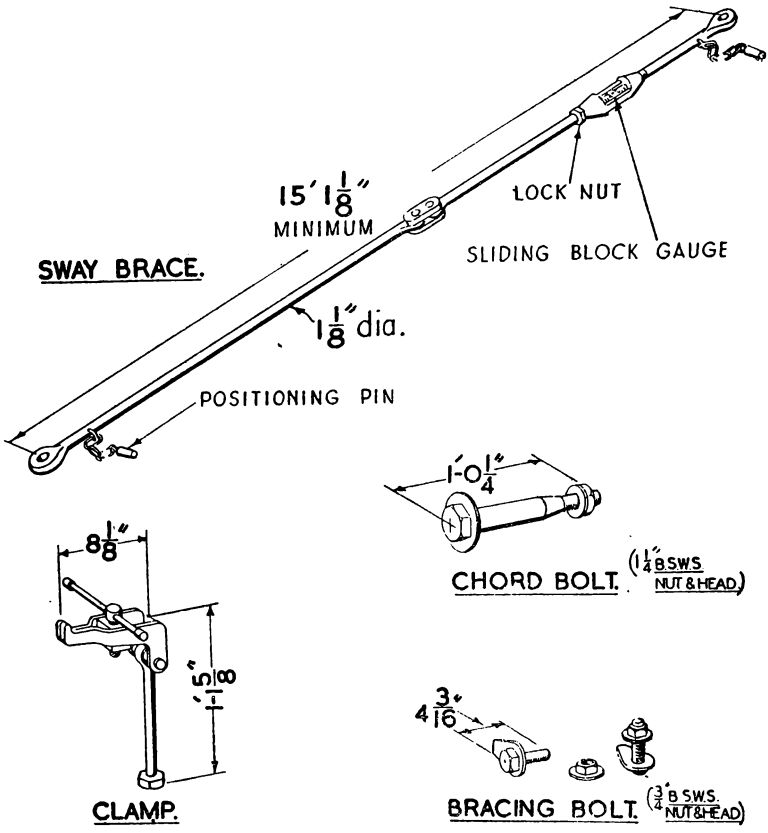
An overhead bracing support weighs 150 lb.

Further details of its use appear in Sec. **26.**

(*e*) *Sway bracing.*—This consists of a mild steel rod, hinged at the centre and containing a turn-buckle for adjustment, the hinge being so placed that one arm is longer than the other. Each end terminates in an eye, a pin on a chain being provided to secure it to the fitting in the panel. Spare sway brace pins are carried in the case, transport, on the accessories lorry.

The turn-buckle, which can be rotated by the tail of one of the erection spanners, is so designed that when it is screwed up tight, with both ends of the rod against the sliding block gauge, the sway brace is correctly tensioned.

PLATE IV



A nut is provided on one of the sway brace rods, which may be tightened up against the turn-buckle, to act as a lock-nut.

Sway bracing is required in every bay of bridge.

A sway brace weighs 65 lb.

(*f*) *Transom clamps.*—These are articulated fastenings used to hold the transom in its seating on the panel. They connect at the junction of the verticals and the bottom chord, and are tightened by a vice-handle type of screw.

A transom clamp weighs 6 lb.

The clamp is not designed to take an upward load and therefore the jacks must not be used under transoms held down by clamps.

(*g*) *Chord bolt.*—This is a mild steel bolt treated to resist rust, whose function is to join the panels one above the other to form double storey bridges. Two are used per panel, the bolts passing through holes provided in the chords.

The chord bolts have a taper half-way along their length to assist in drawing the panels into their correct alignment.

A chord bolt weighs 8 lb.

(*h*) *Bracing bolt.*—The bracing bolt is rust proofed, and is fitted with a special lug on the head to prevent rotation when tightening the nut. It is used for the following purposes :—

(i) Attachment of rakers to transom and panels.

(ii) Attachment of bracing frames to panels.

(iii) Attachment of tie plates to panels.

In each it is inserted into the hollow conical dowels and serves to draw the components into alignment. So long as the bolt can be inserted through the dowel and the hole of the member concerned, there is no need to push home the dowel, as tightening on the bolt will complete correct alignment.

A bracing bolt weighs 1 lb.

3. End of bridge members

(*a*) *Ramps, plain and button.*—Ramps are made of three R.S.Js. of high tensile structural steel welded into a frame, stiffeners being provided for additional strength. They are fixed at the ends in precisely the same manner as the stringers and are 10 ft long. For a 20-ft. ramp at each end of bridge, two spans must be used, supported at the junction on an intermediate transom, carried on four RAMP PEDESTALS.

The unsupported span of 10 ft. will take class 40 loads without trouble, but for all greater load classes improvised packing must be introduced at mid-span.

Button ramps are similar, with the addition of 12 buttons on the outside R.S.J.

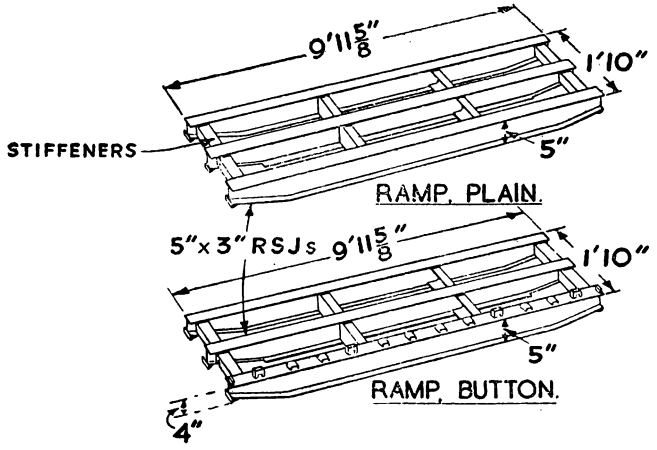
A plain ramp weighs 360 lb. and a button ramp 370 lb.

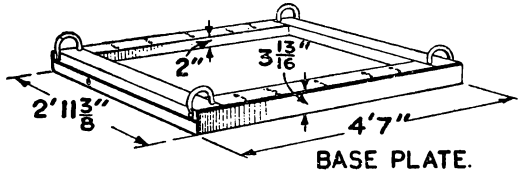
(*b*) *Ramp pedestals.*—These are used as described above to stabilize the intermediate transom between two bays of ramps.

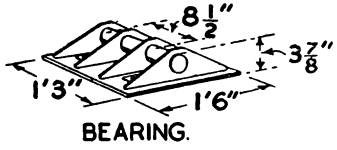
They are " welded-up " assemblies into which the transom fits, being held there by its own weight. Four are used per transom. They can either all be positioned to fit into the spaces between the ramp sections, or alternatively two can be placed outside the outer ramp section. The pedestal weighs 95 lb.

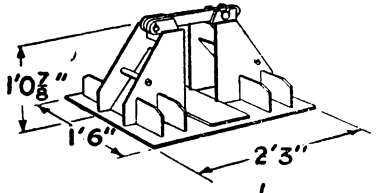
(*c*) *End posts.*—Except for certain short span bridges (*see* Sec. **30**), end posts must be attached to the end of each

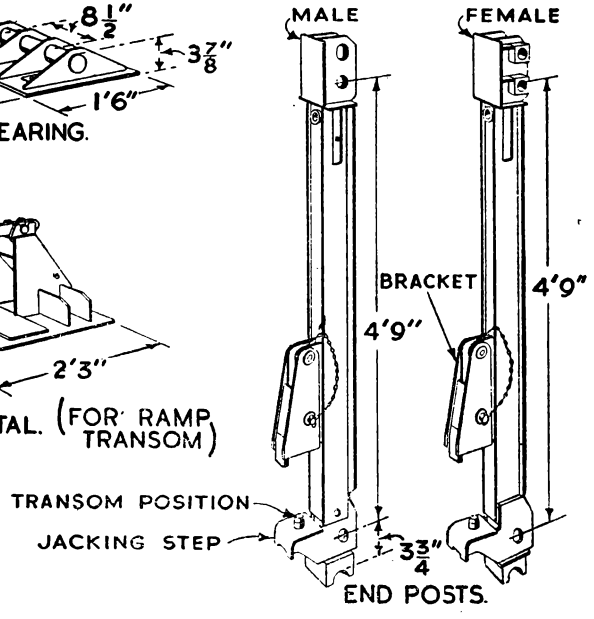
PLATE V


9'11 5/8"
1'10"
STIFFENERS
5"
RAMP, PLAIN.
5"x3" RSJs
9'11 5/8"
1'10"
5"
RAMP, BUTTON.
4"


2"
3 13/16"
2'11 3/8"
4'7"
BASE PLATE.


8 1/2"
3 7/8"
1'3"
1'6"
BEARING.


1'0 7/8"
1'6"
2'3"
PEDESTAL. (FOR RAMP TRANSOM)


MALE
FEMALE
BRACKET
4'9"
4'9"
TRANSOM POSITION
JACKING STEP
3 3/4"
END POSTS.

truss of each main girder. The function of the end post is to distribute the shear forces due to the end reaction of the bridge.

The end posts are of two types, male and female, and are connected to the lugs at the ends of the panel with the ordinary panel pin. Two holes are provided at the top end of the post ; one for connecting with the bottom storey panel, and the top one for connecting with the second storey panel. The lower end of each end post embodies a half-round bearing block, which fits over the BEARING.

A step is fitted to the end post to carry the transom, which has always to be placed outside the end panel vertical at the head of the bridge only. This step is used for jacking, but jacks may also be placed under the transom carried by the end posts, because this is held in position by a hinged bracket.

The step on a male end post will take 15 tons ; on a female end post it will take 12 tons, but by inserting a transom it will take 15 tons.

End posts weigh 130 lb., both male and female.

(*d*) *Bearing.*—The bearing is a welded steel assembly carrying a round bar upon which the half-round bearing of the end post rests. This bar is divided into three lengths by two stiffeners. In the single truss bridge the end post is arranged to bear on the centre length ; in the double truss bridge, two bearings are used, so that each truss rests on the centre length of each bearing ; in the triple truss bridge, the inner truss bears as before, but the outer trusses bear on the two outer positions of the second bearing. Thus it is never necessary to use more than two bearings at each end of each main girder for any bridge. Bearings spread the load to BASEPLATES and weigh 70 lb. each.

(*e*) *Baseplate.*—The baseplate is designed to spread the load from the bearings evenly over an area of ground.

It is a welded steel assembly of which the centre forms a sunken platform to take the bearings. One baseplate is sufficient for one corner of the bridge, whether the construction is of single, double, or triple truss, but the bearing pressure on the ground must be checked.

Certain numbers (1, 2 and 3) will be found embossed on the edges of the baseplates. These indicate the correct position for the centre line of the inner truss of single, double and triple truss bridges respectively, and by aligning the appropriate number nearest the decking with the inner truss, the correct transverse position for the base plate is found for each type of bridge.

The bearing can move 9 ins. longitudinally on the baseplate. For bridges on fixed supports, this movement is largely to assist in erection. For floating bridges the

movement is required to compensate for changes in the length of the bridge due to changes of water level, and to the passage of loads.

The area of the baseplate is 13 sq. ft. By reference to Appendix B, it will be seen whether or not grillage is required under the baseplate, having regard to the bearing pressure of the ground.

The baseplates should always be used if possible, but in certain cases the bearings can be placed directly upon timber on the ground, provided that a careful check is made that the crushing stress produced under the bearing plate is not greater than the safe value for crushing of the timber used, and that adequate spread of the load is achieved according to the safe bearing pressure of the ground.

A baseplate weighs 400 lb.

4. Footwalk members

Footwalks.—These form a trackway 2 ft. 6 ins. wide on each side of the bridge. They are supported on footwalk bearers, which are pressed steel built-up members, fitting over and under special lugs which are welded to the ends of the transoms. These bearers are fitted to the transoms every 5 ft., *i.e.* on every transom in class 40 bridges and below, and on every other when the transoms are doubled.

The footwalk lies across the bearers, being positioned by lugs, and by its own battens.

The footwalk posts drop into sockets at the end of each bearer and may be fitted with split pins to prevent their accidental removal. This fitting need not be done until the bridge is complete. The footwalk post is provided with two eyes for handrail ropes.

Hand-ropes 2 ins. in circumference are threaded through the eyes in the posts, to form the hand rail and are either made fast to some suitable object on shore at each end or are secured to the end footwalk posts.

Footwalk bearers weigh 20 lb. each.

Footwalks weigh 98 lb. each.

Footwalk posts weigh 7 lb. each.

CHAPTER 3

ERECTION TOOLS AND LAUNCHING EQUIPMENT

SECTION 4.—DESIGN AND PURPOSE OF EACH PART

In this chapter the equipment and tools are described in parts according to their use either for launching purposes or for erection of the bridge itself. The facts given will include use of the equipment only so far as is necessary for description; specialized and detailed uses will be found in the appropriate section.

1. Launching equipment

(*a*) *Rocking rollers.*—In launching long spans, severe local bending stresses occur in the bottom chord of a bridge at the point where it passes over the bankseat roller. The rocking roller has been designed to overcome this difficulty, by spreading the load over a length of 3 ft. 6 ins. Three rollers are housed together in a balanced arm, which fits over, and is free to rock on, the bridge bearing. Side rollers are provided on each side of the rocking roller frame to act as guides for the trusses. These can be removed easily if necessary.

For double or triple truss bridges, the number of rocking rollers to be used on the near bank depends on the launching weight of the bridge.

The maximum allowable load on one rocking roller is 21 tons, but in single storey bridges the allowable stress on a panel chord limits this to 15 tons.

The rocking roller weighs 202 lb., and its height when resting on bearing plate and template is 16½ ins.

(*b*) *Plain rollers.*—The plain roller consists of a welded housing containing a single roller, in two halves. It is immaterial on which half roller single trusses are carried, but the second and third trusses together fill most of the available width.

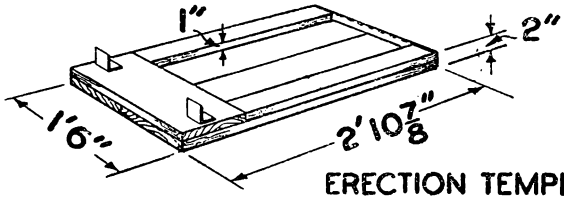
The maximum allowable load on one plain roller is 6 tons for any make-up of bridge.

A plain roller weighs 105 lb., and its height is 8 ins. including the template.

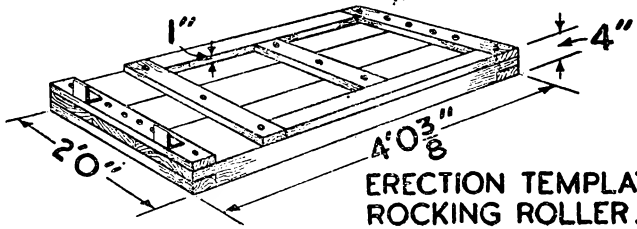
(*c*) *Templates.*—These are used to assist in setting out rollers and are of two types: (i) for rocking rollers; (ii) for plain rollers.

(i) *Rocking roller templates.*—These consist of a timber base with battens screwed to the top, forming a

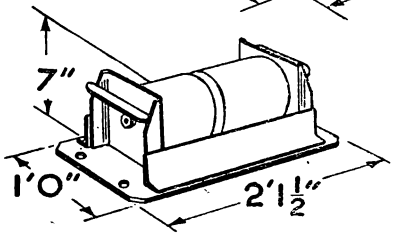
PLATE VI



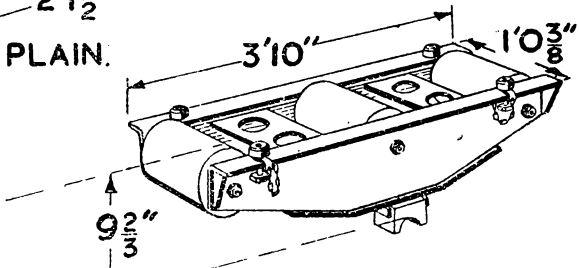
ERECTION TEMPLATE
PLAIN ROLLER.



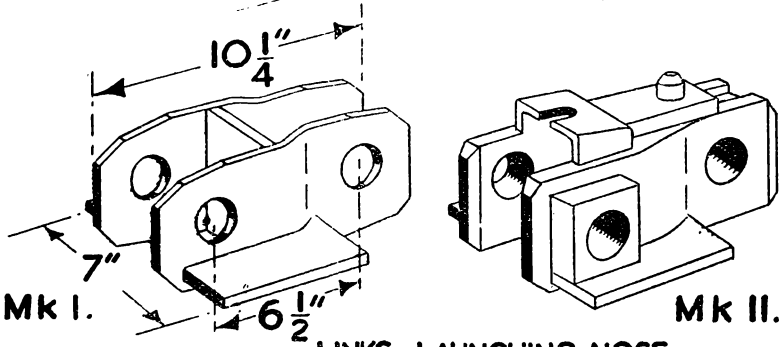
ERECTION TEMPLATE
ROCKING ROLLER.



ROLLER, PLAIN.



ROLLER, ROCKING.



LINKS, LAUNCHING NOSE.

platform, in which the base of the bearing plate supporting the rocking roller is placed. Two angle iron cleats are provided at one edge, so that with the aid of a stringer the template can be correctly positioned with regard to the centre line.

A rocking roller template weighs 100 lb.

(ii) *Plain roller template.*—This is of similar construction to the rocking roller template, and takes the base of the plain roller. Similarly it has angle iron positioning cleats for use with a stringer.

A plain roller template weighs 30 lb.

When using the stringer, the end cross member is butted up against the cleats on the templates.

(*d*) *Links, launching nose, Mk. I and Mk. II.*—The launching nose link is inserted in the bottom chord between two panels of the skeleton nose; thus by lengthening the bottom chord it raises the skeleton nose up, overcoming the natural sag of the bridge. For each bay back from the front that the links are fitted, the nose is lifted 13½ ins.

The Mk. I link consists of male and female lugs back to back, with a flange welded to the base for ease in pushing across the rollers. This link is not as strong as the bottom chord of the panel, and must not be fitted more than 4 bays back from the front. Two pairs of links may be inserted in these front 4 bays.

The Mk. II link is of similar but stronger construction, and will take the same load as the panel chord. It should not, however, be placed more than four bays back when used in the skeleton nose, owing to the stresses produced. It may be used anywhere in the bridge proper. The nose is raised by the same amount as with the Mk. I link.

The Mk. I link weighs 12 lb., and the Mk. II weighs 28 lb.

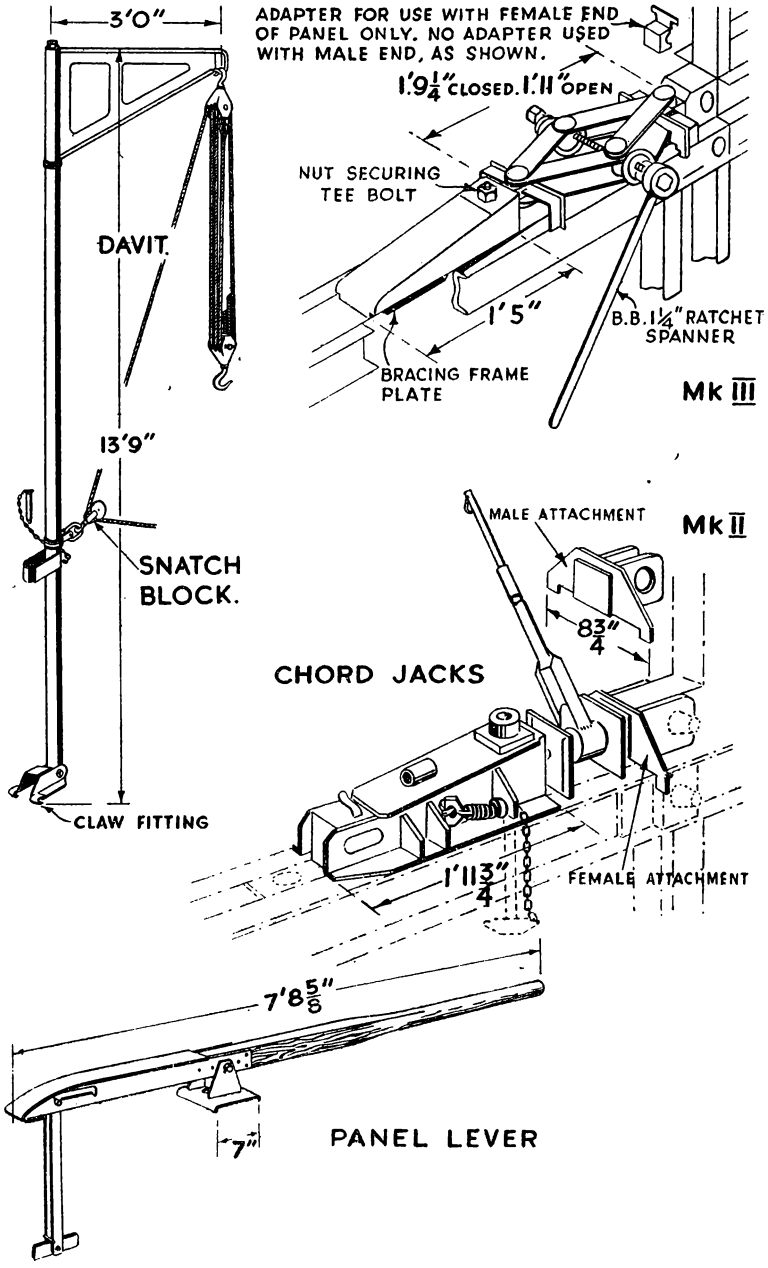
2. Erection tools

(*a*) *Panel lever.*—The lever is designed to assist in the erection of the second and third trusses, after the inner truss is in place. It is a wooden bar with a hinged metal seating at the centre and a lifting link at the end. The lifting link has a swivelling cross piece which can readily be attached to the top of a panel by passing it through the chord and turning it so that it fits crosswise under the flange. The lifting link slides in a slot in the lever arm, the inner end of which is used when erecting the second truss and the outer end when erecting the third truss. The metal seating, placed on the inner truss, acts as a fulcrum.

Two levers are needed per panel with two men on each handle.

The lever weighs 45 lb.

PLATE VII


3'0"
DAVIT.
13'9"
SNATCH BLOCK.
CLAW FITTING
ADAPTER FOR USE WITH FEMALE END OF PANEL ONLY. NO ADAPTER USED WITH MALE END, AS SHOWN.
1'9¼" CLOSED. 1'11" OPEN
NUT SECURING TEE BOLT
1'5"
B.B. 1¼" RATCHET SPANNER
BRACING FRAME PLATE
Mk III
MALE ATTACHMENT
Mk II
8 3/4"
CHORD JACKS
1'11 3/4"
FEMALE ATTACHMENT
7'8 5/8"
7"
PANEL LEVER

(*b*) *Davit.*—The davit is provided for converting a bridge from single to double, or double to triple truss, after it has been launched over the gap.

It consists of a vertical tubular member with a short swivelling arm at the top, from which a 2-in. treble-treble cordage tackle is suspended. A 2-in. snatch block is also provided so that a horizontal pull can be obtained with men standing on the deck of the bridge ; this is hooked into an eye provided in the centre of the upright.

The davit is fixed on the inner truss and rests on the bottom chord, having a base fitting with a claw edge which engages under the flange of the channel. It is prevented from overturning by a steel pin which fits into the chord bolt hole in the top chord of the panel. The base is hinged in order to permit its passage between the panel and the decking, but even so a chess must be moved to provide sufficient space.

The davit is used in conjunction with the lever for adding a second or third truss to an existing bridge, panels being brought along the deck and swung out over the top of the existing truss. It should be noted that in so doing the panel is turned through 180 degrees and care must be taken to see that the panel is brought up on to the bridge correctly.

The davit weighs 175 lb.

(*c*) *Chord jack.*—The bridge has a definite natural sag due to the clearance in the pinholes and the weight of the bridge. This makes it difficult to insert the top pins in the panels of the second storey when it is being added to a single storey bridge *in situ*. The chord jack is provided to overcome this difficulty.

There are three types of chord jack available at present of which one, the Mk. I, is obsolescent. Mk. II or Mk. III jacks only are now being produced. Each type is described below :—

(i) *Mk. I.*—This type of jack consists of two welded steel frames which fit on the top chord of the second storey, one on either side of the joint in which it is required to insert the pin. The two frames butt up against the plates on the panel which locate the holes for fixing bracing frames, and transfer the horizontal thrust to the panel chord. Vertical movement is prevented by a bolt passing through the jack frame and anchoring under the bottom flanges of the upper chord. If the panel is upside down, the jack can be used by passing the fixing bolt through the sway brace pinhole.

Between the two frames is fitted a screw jack attachment with a reversible ratchet lever. This forces the jack frames, and therefore the top of the

panels, apart to allow insertion of the top pin. The complete set weighs 119 lb.

(ii) *Mk. II.*—The Mk. II jack serves the same purpose. Instead of fitting to the top chord of the second storey, however, and forcing the top pin joint apart, it is designed for use on the top chord of the bottom storey, and forces the bottom pin joint of the second storey panels together, the top pin having been previously inserted.

The Mk. II jack consists of two parts. One is a welded assembly similar to, but smaller than the Mk. I assembly. This is attached to the top chord of the bottom storey in exactly the same way as described for the Mk. I jack. The other part consists of either a male or female attachment which is fastened by a panel pin to the appropriate female or male lug on the bottom chord of the second storey panel. The screw jack fits between the frame and the stop, and forces home the bottom pin joint of the panels concerned.

The complete set weighs 99 lb.

(iii) *Mk. III.*—The Mk. III jack is also used on the top chord of the bottom storey panels, to force home the bottom joint of the second storey panels. The screw jack principle is, however, discarded, and a double lever action is substituted so that the maximum force is available near the end of the travel, where the resistance of the panels is greatest.

The jack is in two portions, one a welded frame which fits on the top chord of the lower storey, and is similar to but smaller than the welded assembly used with the Mk. II jack. In this case it fits across the top chord plate which locates the holes for fixing the bracing frame and has lugs on the underside which butt up against this plate. A further lug is fitted beneath the tail of assembly which fits between the chord channels and prevents lateral movement. The assembly is held down by a bolt passing through the chord as for the jacks described above.

The moving portion of the jack is in the form of a diamond, which is pin jointed at each corner. Across one axis a rod is fitted which passes through the arms of the diamond at the centre joint, and is screw threaded at each end. At each end of the rod hexagonal nuts are fitted which butt up against the joints of the diamond, so that tightening on one of the screws with the normal Bailey ratchet spanner forces the two centre joints together and elongates the opposite axis of the diamond. One

joint of this axis butts up against the fixed part of the jack, the other butts straight up against the male jaw of the top storey panel. In the case of the female jaw, a special attachment is provided which is used in conjunction with the normal panel pins.

When the jacks are used with triple storey bridges, the same positions are occupied, but are one storey higher in each case.

(*d*) *Pin extractor.*—This tool is normally required for extracting pins from the outer truss of triple truss bridges. The need for it arises from the fact that the second and third trusses are so close together that it is not possible to drive out the pins with a hammer.

The extractor has an adjustable fitting which fits over the head of the pin and is then tightened to grip beneath the pin head. This is on the end of a steel arm which is provided with an adjustable fulcrum at its centre so that the pin can be levered out. In order to get a grip, the head of the pin must first be forced out a small distance from the face of the panel chord. This is most easily accomplished by driving the pin of the second truss outwards so that it strikes the tapered end of the pin required to be moved in the third truss and pushes the head clear.

(*e*) *Jack.* The jacks provided with the equipment are of ratchet and lever type of 15-ton rated capacity ; they are provided with a toe to fit under the jacking step on the end post. It should be noted that only half the rated capacity of the jack should be carried on the toe. A jack of this type weighs 112 lb.

(*f*) *Jack shoe.* The jack shoe is a welded assembly designed to fit over the bearing plate and provide a secure base for the jack when used under the step of the end post. The shoe weighs 36 lb.

(*g*) *Hammers.* No hesitation need be felt in forcing panel pins home with the aid of a hammer.

Hammers, hide faced, are provided for this purpose, the hide face serving to deaden the noise.

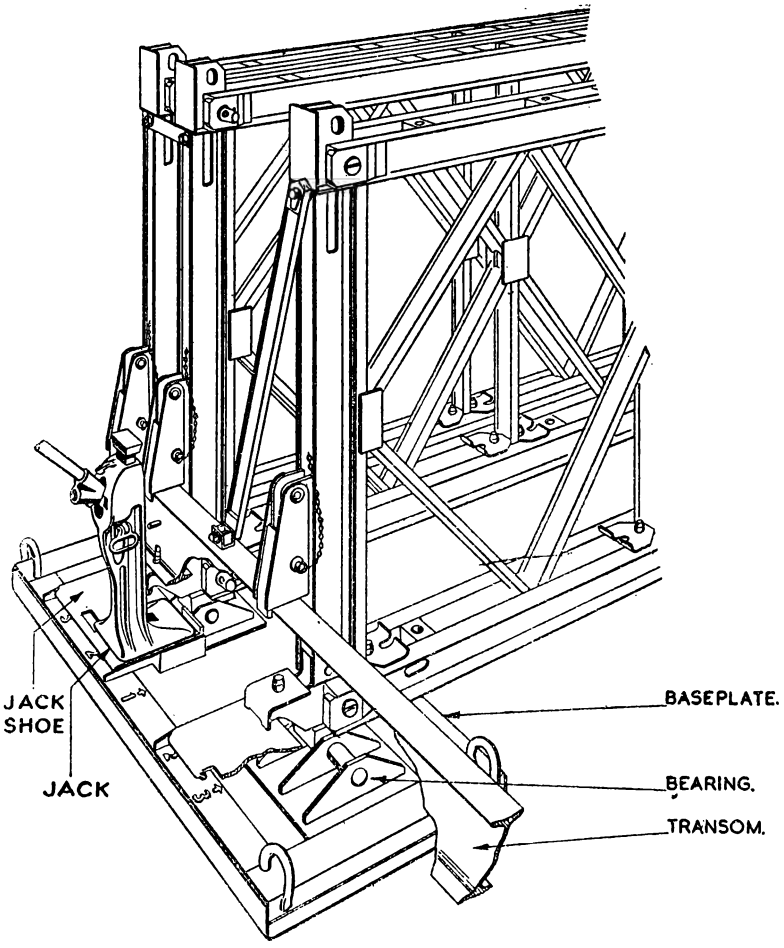
Sledge hammers are also provided in the accessories lorry for general use at the bridge site.

Spanners. In single storey bridges, except for sway bracing, only one size spanner is required, namely $\frac{3}{4}$-in. For tensioning sway bracing and tightening lock nuts, a $1\frac{1}{4}$-in. spanner is required. The $1\frac{1}{4}$-in. spanner is also used for chord bolts in double or triple storey bridges. The following types of spanner are provided :—

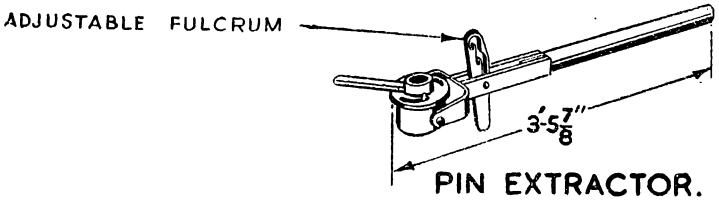
(i) Single-ended $\frac{3}{4}$-in. podger.

(ii) Cranked box spanner, $\frac{3}{4}$-in. Most useful for tightening vertical bolts, *i.e.* on bracing frames and on ribands.

PLATE VIII



JACKING ARRANGEMENT
(ONLY ONE JACK SHOWN)



PIN EXTRACTOR.

(iii) Single ended $1\frac{1}{4}$-in. podger. For tightening chord bolts, and sway brace locknuts.

(iv) Ratchet spanner $1\frac{1}{4}$-in. For tightening chord bolts.

Spanners are very easily lost. Some improvised means of attaching them to their user should always be adopted.

(*h*) *Carrying bars.* These are wooden bars, reinforced by a steel band at the centre. They are used for carrying panels, transoms, and base plates.

CHAPTER 4

ERECTION AND LAUNCHING—SINGLE STOREY BRIDGES

SECTION 5.—GENERAL—SINGLE STOREY CONSTRUCTION

The normal method of constructing and launching single storey bridges is by the cantilever method with a skeleton launching nose of calculated length. The bridge is constructed on rollers, and is rolled forward over the rocking rollers on the home side of the gap until the point of balance of the bridge and launching nose together is reached. The nose will then be over the landing roller on the far bank. When the nose has been lowered on to the landing roller, the whole is pushed forward until the ends of the bridge proper are over the prepared baseplate positions. The bridge is launched completely decked.

The launching nose is then dismantled on the far bank. Meanwhile on the home bank jacks are fitted under the tail of the bridge, and it is lifted clear of the rollers, which are now removed. The tail of the bridge is then jacked down on to the bearings. The process is repeated at the head of the bridge as soon as the nose is removed and jacking at the tail completed. Finally, ramps are fitted at each end of the bridge.

The general principle in building and launching single storey bridges is that the bridge should be fed forward over the gap as new bays are constructed at the tail. The point of balance is thus kept as nearly as possible on the launching rollers. In practice, there will be a tendency for the tail of the bridge to rise from the construction rollers when too near the point of balance, when this occurs the bridge must be pulled back a few feet.

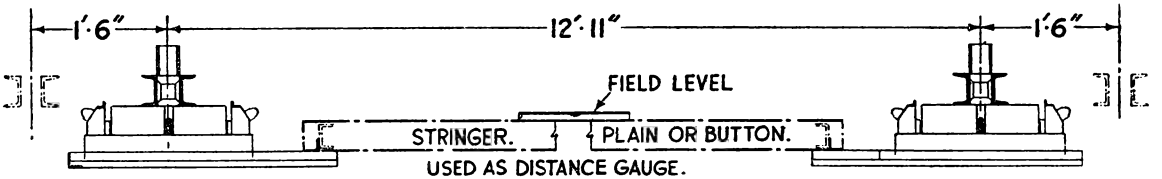
Full details of the various operations in construction and launching of a single storey bridge are contained in the ensuing sections.

SECTION 6.—ROLLER LAYOUT

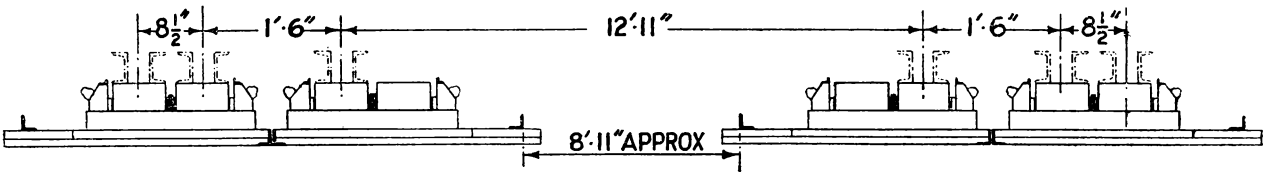
1. The rollers are used in three ways: launching rollers on the home bank, landing rollers on the far bank, and construction rollers spaced out behind the launching rollers at specified intervals. Rocking rollers are invariably used for the launching position, and for the landing position except in light bridges; in all other positions plain rollers are used.

2. Launching rollers are placed as near to the edge of the gap as consideration of load and the angle of repose of the ground will allow. They are normally put in front of the baseplate position, so that when the bridge is finally in place, the end post will be central over the baseplate. The centre of the rocking roller should be put 3 ft. 6 ins. in front of the centre of the baseplate. This distance may be made less if necessary, but should never be reduced to below 2 ft. 6 ins. because otherwise the arm of the roller will come over the centre of the baseplate and hinder jacking operations.

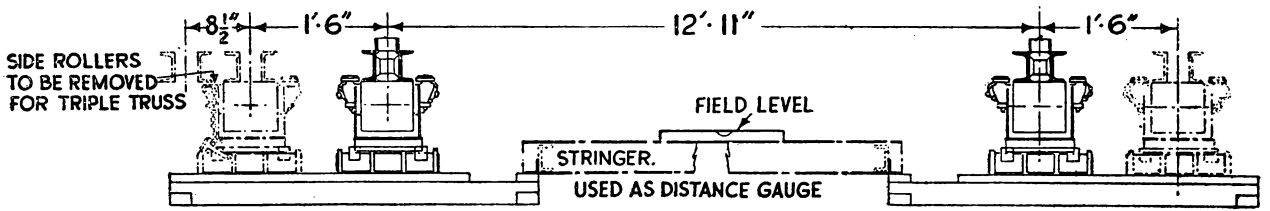
ROLLER LAYOUT · LATERAL SPACING



PLAIN ROLLER 27' AND 77' POSITIONS



*PLAIN ROLLERS 52' POSITION



ROCKING ROLLERS

* Inner rollers can be positioned with stringer, and outside rollers staggered behind. This arrangement needs less grillage.

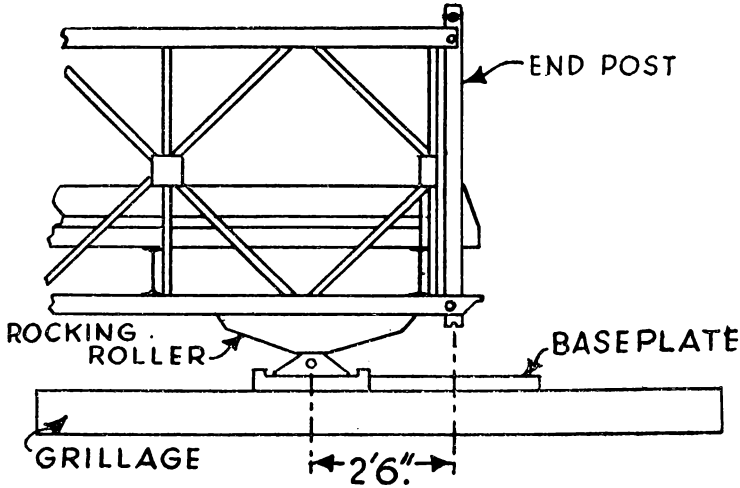


FIG. 2

Laterally, the rollers are placed equidistant from the centre line of the bridge at the same distance centre to centre as the trusses of the main girders, *i.e.* 12 ft. 11 ins. centre to centre if one pair only is being used under the inner trusses. Where another pair of rollers is needed they will be 15 ft. 11 ins. centre to centre. The maximum number used is two each side of the bridge, as there is not sufficient space between the second and third trusses to fit another roller. For the same reason, when launching triple truss bridges, the side rollers must be removed on the outer edge of the outer roller on each side.

The number of launching rollers required is determined by the weight of the bridge and nose (all of which is carried by these rollers when at the point of balance), and the fact that in single storey construction a rocking roller will take 15 tons load.

Example :— 110 ft. triple single weighs 33·2 tons.
7 bays of nose weigh 5·25 ,,

Total weight = 38·45 ,,

$$\text{No. of rollers} = \frac{38{\cdot}5}{15} = \text{greater than two.}$$

∴ four rollers will be used, two on each side of the bridge.

Launching rollers *can* be used placed behind the baseplates ; but, in order to get the end of the bridge into its final position over the baseplates, additional panels must be fitted on behind to rest on the rollers. The rollers should then be 3 ft. 6 ins. *behind* the centre line of the baseplate. The effect of using rollers in this position is described in Sections **8** and **16**.

3. One set of landing rollers will be sufficient for all single storey construction work; these may be plain rollers for up to 80-ft. span double single and 60-ft. span triple single. For all bridges above this span, rocking rollers must be used. The remarks on the positioning of launching rollers apply equally to landing rollers.

4. The first set of construction rollers is placed 27 ft. back from the centre of the rocking rollers. These are always plain rollers, and only one roller on each side of the bridge is used, at 12 ft. 11 ins. centres. A further set of rollers, if required, is placed 25 ft. farther back; that is, 52 ft. from the rocking roller. These will only be required for longer spans, and therefore heavier bridges; consequently four plain rollers, two each side, are always used in this position.

5. It is essential that all rollers on the home bank should be in the same plane, and that they should be levelled across in pairs at right angles to the centre line. The line of sight through the tops of the rollers is termed the launching plane of the bridge.

Templates are provided with the rollers to simplify the setting out. They are correctly positioned when a stringer is placed across between the positioning cleats on the templates so that its end stiffening section is butted up against the face of the cleat, and the centre of the stringer coincides with the centre line of the bridge. This arrangement also makes levelling across in pairs much simpler, but the templates must be checked for level at the same time, because the stringer is only resting on the inner edges.

SECTION 7.—LAUNCHING NOSE

1. The length of nose for all spans of bridges will be found in Plates XVIIA–F. The principle on which these tables are worked out is that with the bridge complete, and the tip of the nose clear over the far landing roller, the weight of bridge and skeleton nose over the gap will be balanced by the weight of bridge on the home side of the launching roller. There is a simple rule for making this calculation :—The length of nose required can normally be taken as half the length of the bridge plus one bay, to the nearest 10 ft. above. By taking moments about the home rocking roller, a check can be made on the balance of the bridge at the point when the nose just reaches the far landing roller.

Example.—80-ft. double single bridge.

$$\text{Length of nose} = \frac{8}{2} + 1 = 5 \text{ bays of nose.}$$

Skeleton nose weighs 0·75 ton per bay.

Double single bridge weighs 2·49 tons per bay.

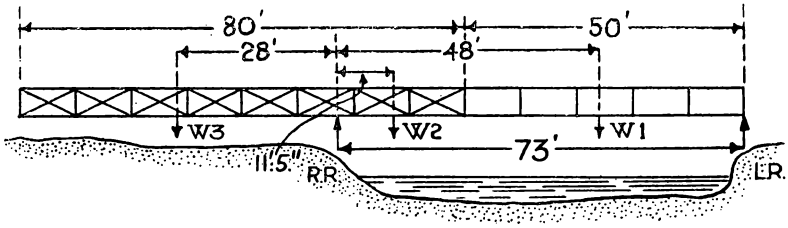


FIG. 3

Taking moments about the launching rollers

(*a*) *Weights over the gap*

	Weight	Distance from RR.	Moment
Nose (W_1)	5×0·75	48 ft.	180 ft.-tons
Bridge (W_2)	2·3×2·49	11·5 ft.	66 ft.-tons
		Total moment	246 ft.-tons

(*b*) *Weight behind launching rollers* (W_3)

Weight	Distance from RR.	Moment
5·7×2·49	28·5 ft.	405 ft.-tons

This calculation shows that the balancing moment is greater than the overturning moment and means that the nose would actually pass some feet beyond the landing roller before the point of balance is reached.

2. The nose is, with the exceptions enumerated in Plates XVIIA–F, always of single single construction. The construction is always as follows :—One transom is fitted per bay behind the uprights with rakers attached to every alternate odd transom, first, third, fifth, etc., and sway braces fitted in every alternate even bay, second, fourth, sixth, etc.

SECTION 8.—RECONNAISSANCE AND LAUNCHING PROBLEMS

1. Length of bridge required

(*a*) The rocking rollers on each bank will be placed a distance back from the edge of the gap according to the angle of repose of the ground. This distance each side, and the distances the rollers are in front of the baseplate (normally 3 ft. 6 ins. each side) will have to be added to the clear

span bank to bank. The nearest multiple of 10 ft. above this gives the actual length of bridge. From Table 1 the type of construction for the load class required can be found.

(*b*) When the launching and landing rollers are placed behind the baseplate, the length of bridge required will be the clear span bank to bank plus an allowance for the angle of repose of the ground only.

Jacking down is more difficult with this second method ; but it has its advantages when there is a shortage of equipment, since the 7 ft. difference might save an extra bay. This saving might also enable a double single bridge to suffice where otherwise a triple single would be necessary.

2. **Grillage under baseplate.**—A separate chapter on types of grillage is included, but it should be remembered that it is at this stage, when the span and construction of bridge have been decided, that the type of grillage required must be selected according to the bearing pressure of the ground.

3. **Launching on to a higher bank.**—The problem here lies in lifting up the tip of the launching nose so that the bottom chord of the panels will clear the landing roller, allowing for the difference in height of the banks and the sag at the tip of the launching nose.

There are three methods of overcoming this problem :—

(*a*) The first is to include one or two launching nose links in any of the first four bays in the skeleton nose. With two links, the inclined position of the nose over the landing roller may make the force required for pushing the bridge excessive for man power alone, three men per ton launching weight being required on a *level* launch.

The height gained at the tip of the nose is 13½ ins. for each bay back that the link is fitted ; thus the maximum lift with one link is 4 ft. 6 ins. and with two links 7 ft. 10 ins.

(*b*) The second method is to adjust the heights of the launching and construction rollers so that the bridge is launched up an incline, the tip of the nose being lifted sufficiently to clear the landing rollers. The main disadvantage with this method is that packing under the launching roller increases the distance through which the bridge has finally to be jacked down.

(*c*) The third method is to combine (*a*) and (*b*), gaining some height by use of the link, and the remainder by packing up the launching roller. This is the one most commonly adopted.

4. After roller heights have been fixed, a check must be made that the tail of the bridge will not ground either (*a*) behind the construction rollers during construction or (*b*) during the launch.

(*a*) The tail overhanging behind the construction rollers can easily be checked by sighting back along the tops of the rollers, and checking that the line of sight does not cut ground level within the distance behind the rollers that the tail will overhang.

(*b*) During the launch, the critical position will be with the launching link just crossing the landing roller as illustrated below, where the link is assumed placed four bays back.

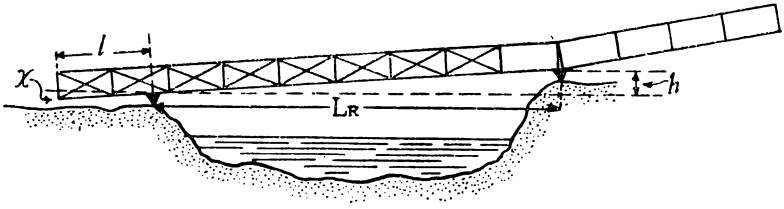


FIG. 4

Distance between launching and landing roller = L_R ft.
Distance of tail behind launching rollers at critical point=l ft.
l=(length of bridge+nose)—(L_R+40).

Then if the landing roller is h ins. above the launching roller, the tail will be x ins. below the launching roller level

$$\text{where } x=\frac{h \times l}{L_R}$$

If in either of the above examples the tail is found to be grounding, the launching rollers must be packed up as well as the construction rollers.

5. The slope of ground on the far bank must also be considered in relation to the launching nose ; if it slopes up, the nose may dig into the ground as it is pushed forward, in which event the nose may have to be dismantled bay by bay as it comes over the landing rollers. The minimum clear space required behind the landing rollers is 12 ft. to 15 ft., so that at least one complete bay of nose can be clear over the rollers. If the ground falls away from the bank, on the other hand, a check must be made that the nose is not so high from the ground at its tip, that it is beyond reach for ease of handling.

Examples of all calculations involved in preceding paragraphs are given at Appendix F.

6. **Launching on to a bank lower than the home bank.**

Preventer tackles should be fitted to each side of the bridge, to control it during the launch ; also launching nose links should always be fitted to overcome some of the sag in the launching nose, and to help the clearance of the nose on the far bank.

SECTION 9.—STORES LAYOUT

The ideal layout of stores for the construction of an 80-ft. double single bridge is illustrated in Plate X. The stores are equally divided on each side, leaving a clear space of 25 ft. each side of the centre line. Stringers and sway braces are placed on the centre line to the rear at a distance equal to the length of the launching nose plus 25 ft. from the edge of the gap. Ramps remain on the lorries until required. The centre space is kept clear for construction.

Very few sites will be met in practice on which this ideal layout can be used. It must be adapted to suit the conditions, bearing in mind the general principle that the stores should be placed as near as possible to the positions in the bridge where they will be used. In longer bridges, the stores should be laid out as for an 80-ft. bridge, with the remainder in the same order as before, beginning behind the panels; stringers and sway braces should be moved back to allow for construction.

SECTION 10.—SETTING OUT DRILL

1. From the considerations set forth in the preceding paragraphs, and as a result of experience, a drill has been devised; it is based on these two assumptions:—

   (*a*) That the recce. party is equipped as laid down in Appendix G to Standing Orders for Divisional Engineers, War, 1942.

   (*b*) That the advance party, equipped with normal section tools and accompanied by the necessary lorries, will arrive at the site as soon as the tactical situation permits.

2. The drill is as follows:—

   (*a*) Determine the best centre line of bridge, considering (i) the line and length of approaches on each bank; (ii) the heights of banks; in that order of importance.

   (*b*) Obtain the clear measurement of the gap.

   (*c*) Determine the minimum safe distance of launching and landing rollers from the edge of the gap, and remember that baseplates must not be nearer than 2 ft. 6 ins (and better, 3 ft. 6 ins.) to the rollers; determine the span of the bridge.

   (*d*) Peg position of baseplates, launching and landing rollers.

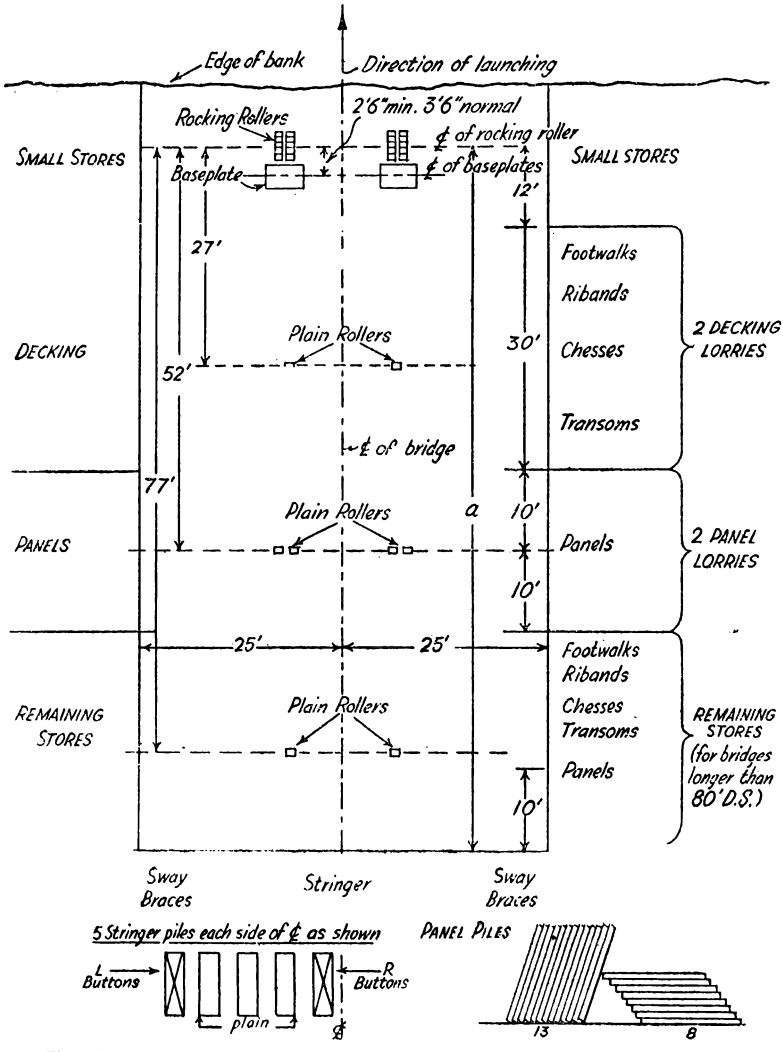
   (*e*) Continue the centre line for full length of estimated nose and tail of bridge.

   (*f*) Determine the number of construction rollers required and peg the positions 27 ft. 52 ft., etc., behind launching rollers.

   (*g*) Knock in and level two pegs on the centre line to form a boning base on the home bank, which can be taken as

PLATE X

SITE LAYOUT



The distance marked "a" can be found from: a = length of nose + 25 feet.

datum level for all the necessary heights; bone through the cross section of the gap, continuing the section for the full length of the nose beyond the landing roller.

(*h*) Calculate from the known ground level at the different rollers the amount of packing or excavation required.

(*j*) Form an estimate of the bearing capacity of the ground, and select the type of grillage required under the rocking rollers, baseplates, and plain rollers from Appendix D.

(*k*) Get the advance party to work at the earliest possible moment on excavation and levelling of grillage positions, and also intermediate transom and end of ramp supports. Spitlock out the necessary excavations, as shown in Appendix E.

(*l*) Peg out stores line 25 ft. from each side of centre line, and mark out positions for stores.

(*m*) As soon as grillages have been laid, or the ground levelled, pack up rollers as required and check that they are square to centre line and level laterally across the bridge. Check back with the boning rods that the tail of bridge will be clear of the ground. Position the baseplates.

(*n*) Allocate platoon and section tasks (Sec. **18**).

Work on construction can begin as soon as all rollers are positioned and packing is firmly fixed against any tendency to fall forwards as the bridge is launched.

SECTION 11.—DOUBLE SINGLE CONSTRUCTION DRILL

1. Nose

(*a*) Place one panel on each launching roller so that the centre of the panel is over the inside edge of the roller and the female jaws are towards the gap.

(*b*) Put the first transom through the front end of the panel behind the front vertical.

(*c*) Connect two more panels, at the same time adding the raker to the front panel and transom.

(*d*) Put the transom through the second set of panels, again behind the front upright.

(*e*) Add two further panels, at the same time placing the sway brace in the second bay.

This cycle is then followed until all bays of the nose have been completed, rakers being added to the 1st, 3rd, 5th, etc., and sway braces in the 2nd, 4th, 6th, etc. bays. For the first three bays of nose until the 27-ft. roller has been reached, the tail end of the panels may have to be supported on packing (chesses will serve quite well); the packing being moved back one bay at a time until the rollers are reached.

2. First bay of bridge proper

(*a*) On completion of the nose, the first two panels of the inner trusses are connected with the last bay of nose.

(*b*) Feed a transom through in *front* of the *centre* upright of the panel.

(*c*) Add the first panel of the second truss by lifting it over the centre transom and holding it in position with the transom clamps. At the same time fix the eye of the long arm of the sway brace to the front connecting positions on each panel.

(*d*) Feed the second transom through in *front* of the rear vertical and a third transom *behind* the front vertical. A raker is positioned on the second transom, and as soon as the raker man has engaged both dowels he calls " Raker in," and the short arm of the sway brace is fixed to the rear connecting position of the panel. In the meantime, the bracing frame has been hoisted into place, and is finally fixed as soon as the raker dowels are in.

(*e*) Put on the outer and inner panels of the next bay, positioning the OUTER (second truss) panel first. The reason for positioning the outer panel first will become apparent when triple truss bridges are considered, but it is best used as a standard drill for both types of construction.

The first bay of bridge is now completely built and braced ; together with the panels of the second bay in position. There is already a transom *behind* the front vertical of the end panel (the *only* transom in the bridge to be fitted *behind* a vertical). This transom prevents distortion of the end bay due to the pull of the sway braces, and therefore makes the fitting of the transom in the end posts easier.

(*f*) Bring up three plain and two button stringers, leaving button stringers on edge until sway brace is tightened. Leave front end of these stringers projecting beyond the first transom. Complete decking of first bay. *See* Sec. **14**, para. 6.

3. Sequence of construction for remaining bays

(*a*) Fit long arm of sway brace in front recess of panels of bay two. Position the outer panels of *bay three*, and at the same time fit the first transom in front of the rear upright of *bay two*. Fit clamps *loosely*.

(*b*) As soon as the transom is fitted in bay two, the raker is put in position between it and the panel.

(*c*) Position the inner panels of *bay three* and connect long arm of sway brace in front recesses.

(*d*) Position the bracing frames of *bay two* as soon as raker man shouts " Raker in," and fix short arm of sway brace in rear recess.

(*e*) Position the centre transom of *bay two*, fastening the clamps loosely.

(*f*) Tighten up the sway brace of *bay two*.

(*g*) Tighten transom clamps.

(*h*) Bring up three plain stringers followed by two button stringers, for *bay two*, the button stringers being left vertical on their sides until tightening of sway brace is completed.

The sequence is thus completed, and it is then continued for bays three and four, etc. It should be noted that all the various jobs are proceeding at one and the same time, and the sequence has been evolved to obviate unnecessary crowding in the centre of the bridge.

SECTION 12.—TRIPLE SINGLE CONSTRUCTION DRILL

1. **Nose.**—Construct skeleton nose to required length as for double single construction.

2. First bay of bridge proper

(*a*) Bring up and connect the first two panels of the inner trusses to the launching nose.

(*b*) Place a transom through these panels in front of the centre vertical and connect the long arm of the sway brace to the front end of the inner panels.

(*c*) Bring up two panels for the second truss and connect them with the centre transom with transom clamps.

(*d*) Position the panels of the *second truss* in *bay two*.

(*e*) Add the first two panels of the third truss in *bay one*, attaching them by the clamps to the centre transom. (Add end posts as Sec. **14**, para. 8).

(*f*) Pass a second transom through all three trusses of bay one in front of the rear upright, and position the raker on each side of bridge to the rear vertical. Position a third transom *behind* the front verticals.

(*g*) Connect the short arm of the sway brace with the rear position, and fix the bracing frame in *bay one*.

(*h*) Position the tie plates in the top raker hole of the front upright of the second and third trusses of *bay one*.

(*j*) Tighten transom clamps and sway brace.

Having completed *bay one* and positioned the panels of the second truss in *bay two*, a cycle of operations can now begin for the construction of the remaining bays of bridge.

3. **Sequence of construction for remaining bays**

(*a*) Position panels for the inner truss of *bay two* and connect sway brace to front recesses.

(*b*) Position panels for the second truss of *bay three.*

(*c*) Position panels for the third truss of *bay two.*

(*d*) Place transoms through in front of rear and centre uprights of *bay two.*

(*e*) Position the raker to the rear transom of *bay two.*

(*f*) Connect sway brace ; bracing frames and tie plates of *bay two.*

(*g*) Tighten transom clamps and sway braces ; position decking stringers of *bay two,* leaving the button stringers on edge until the sway brace tightening is complete.

(*h*) Continue the sequence for *bays three* and *four* and succeeding bays until construction is completed.

SECTION 13.—METHOD OF ADDING THE SECOND OR THIRD TRUSS TO EXISTING BRIDGE

1. When an existing single or double truss bridge is required to be increased in load capacity by the addition of extra trusses, the following method should be adopted :—

(*a*) Carry the additional panels on to the deck of the bridge, female lugs foremost, and upside down.

(*b*) Lift the panels, pivoting about the top chord of the existing truss(es), push it outwards, and by means of lashings lower it until the bottom chord is below the transoms. Final positioning is then done with the aid of the panel levers.

2. If davits are available, they are positioned on the inside truss of the bay to which the panel is to be added. Panels are then brought on to deck the correct way up, but with male lugs foremost. They are then lifted and swung out over the existing trusses by the davit (which will turn them through 180 degrees), and finally positioned, as before, by the panel levers.

3. The following general points should be noted :—

(*a*) In both methods, double and triple-trussing starts from the centre bay of bridge working outwards in both directions, so that the sag is taken out of the existing truss or trusses evenly.

(*b*) If the load class is to be increased above Class 40, transoms will have to be doubled throughout the bridge.

SECTION 14.—ERECTION HINTS

In all single storey bridges the following points should be noted :—

1. The bridge should normally be pushed forward over the gap as each two or three bays are completed behind the construction rollers.

2. The simplest method of adding the first panels of the two outer trusses is as follows: the carrying party lift the panel over the end of the transom so that the transom is just in front of the centre vertical and directly over the transom seating. Two men hold the panel vertical, while the remaining four men of the panel party place a hand spike under each end of the panel and lever it up, so that the positioning dowel engages with the transom. The panel is then held in position by the transom clamp.

Panel levers can be used to position these panels, but this method is not so quick as that described above. Separate men have to be detailed to operate the levers. The panel in this case is lifted into position instead of being levered up by the handspikes.

The remaining panels of the inner and second trusses present no difficulty, since they can be pinned directly into position. The remaining panels of the third truss should be positioned in the following manner:—

Lay down a handspike at right angles to the bridge just behind the end of the last panel of the third truss. The next panel is then brought up as close as possible and lowered on to the handspike. Carrying bars and inside working numbers are then withdrawn, and the panel is pushed into line with its predecessor. By levering up with the handspike, the front pin can be engaged at the bottom. The rear end is then lifted, and the front pin engaged at the top.

3. It is essential that any difficulty in positioning any of the bracing members is reported immediately, otherwise the sequence of construction will be interrupted and difficulties will increase.

4. Decking must keep pace with the remainder of the construction. Positioning of chesses will be speeded up if they are fed through from one side of the bridge only at a time. If necessary, chessing down can be left until the bridge is launched, when it will present no difficulties.

5. It is important that sway braces and transom clamps are not tightened in any bay until the transoms, rakers, bracing frames, and tie plates of that bay have been fitted.

6. Lay the stringers of the first bay of decking on top of a chess placed across the transom behind the front panel verticals. When the end post transom is inserted, this chess can be pushed clear by crowbars, and the decking will drop into position.

7. It will be noted that the panels in the second truss are positioned one bay ahead of the panels in the third truss in all cases. If this is not done, it will not be possible to insert the pin in the second truss because there is insufficient space between the second and third trusses with both panels in position.

8. The difficulty which arises in fitting end posts to triple truss bridges can be overcome as follows:—

Before the first and last panels of the outer trusses are positioned in bridge, end posts are fitted to them, the pins

being inserted so that they point outwards when the panel is positioned. The end posts on the second trusses can then be positioned without difficulty, with the pins pointing outwards. The last panels of the outer truss can be left, if necessary, until the bridge is clear of the construction rollers.

SECTION 15.—LAUNCHING

Mechanical aids to launching will only be necessary where the launching plane has a steep slope up or down. A 3-in. heavy gyn tackle will normally suffice in these cases, being used either as a hauling or a preventer tackle. In either event the anchorages should be placed as nearly as possible in line with the girders of the bridge, so as to give a direct pull. When attaching the running end to the bridge with a sling or strop, this must pass round a panel upright, but must NOT pass under the bottom chord where it will interfere with the rollers.

The bridge is pushed forward on completion of construction by all available men round the tail of the bridge. This is controlled by the bridge commander, who should station himself at the side of the bridge on the home bank where he can watch the landing rollers and the general position throughout the launch. A senior N.C.O. should control the men at the tail of the bridge, working on the bridge commander's signals.

Should it be found that the nose will not land on the landing rollers on the far bank, the bridge can easily be swung when at its point of balance by pushing sideways on the tail. One man should be stationed on each of the landing rollers to help in guiding the nose on to them. Launching continues until the end posts of the tail of bridge are central on the baseplate, when parties are sent over the bridge to dismantle the nose.

SECTION 16.—JACKING DOWN

The jacks provided with the Bailey equipment may be of different makes and slightly different pitches. When this is so, care must be taken that the jacks used together on each side of the bridge are of the same make, so that there is no danger of them getting out of phase with each other.

1. **Rollers in front of baseplates.** — On completion of launching, the bridge is resting on the launching and landing rollers on each bank, with the ends of the bridge over the centre of the baseplates. The tail of the bridge can be jacked down immediately whilst the launching nose is dismantled on the far bank. As soon as the nose is dismantled, preparation should be made so that jacking can begin on the far bank immediately the bridge has been lowered on to its bearings on the home bank. AT NO TIME SHOULD THE BRIDGE BE SUPPORTED ON JACKS AT BOTH ENDS. If the bridge slopes down from the home bank, tackles should be rigged to obviate the danger of its slipping off the jack toe.

The number of jacks required can be found by dividing half the weight of the bridge by the allowable load on the toe of the jack ($7\frac{1}{2}$ tons) ; thus with a triple single Class 40 bridge 110 ft. span, the number of jacks is

$$\frac{11 \times 3}{2 \times 7{\cdot}5} = \frac{33}{15}$$

This gives more than 2, therefore 2 jacks will be used each side under the inner and second trusses.

Before the jacks can be positioned, the bearing plates must be centralized under the end posts. Care must be taken to ensure that the bearings are directly underneath and in correct alignment with the half round bearing block of the end post. There is very little play when the jack shoe is placed over the bearing, and the shoe cannot be moved when it is supporting the weight of the bridge. Time will be wasted if the bearing block does not sit correctly on the bearing plate, since the bridge will have to be lifted clear and rested on packing whilst the jacks are moved and the bearing plate adjusted.

Once the bearing plate has been positioned, the jack is placed on the shoe, the toe being lifted so that it engages beneath the jacking step on the end posts. The jack handles are inserted and three men detailed to each handle. Two further men should be detailed, one to each pair of jacks to act as checkers. Meanwhile packing is inserted under the bottom chord of the bridge on both sides, and sufficient spare timber placed handy, to ensure that during the whole time that jacking is in progress there is never more than 2 ins. clearance between the bottom chord and the top of the packing. This packing minimizes the risk of damage if there should be any failure of the jacks.

Jacking can then begin, the bridge being first lifted clear of the rocking rollers, which are withdrawn. The simplest method is to slide the rollers and template out to one side together ; then the jacks are reversed and the bridge lowered on to its bearings.

It is essential that the men on the jacks should work together the whole time, and the commander of the party must ensure this result by giving the time for upward and downward strokes of the handles. If one of the jacks gets out of phase with its neighbour the weight which should be borne by two jacks will be taken by one only. It is the duty of the checkers to inform the N.C.O. in charge of the party immediately if either of his jacks fails to register.

2. **Rollers behind baseplates**

(*a*) When the weight of the bridge requires only two jacks, these are placed under the end vertical of the outside truss of the last bay of bridge proper. The false tail is then lifted clear of the rollers, and the panels removed. End posts are fitted and the bridge lowered on to its bearings without altering the position of the jacks.

(*b*) In the second case, where four jacks are required to take the weight, the method is as follows :—

(i) Position jacks under the end vertical of each additional panel of the false tail and lift the bridge clear of the rollers.

(ii) Remove the rollers and pack under the first bay of bridge proper.

(iii) Lower bridge on to the packing and remove the additional panels.

(iv) Fix end posts to the bridge proper and reposition jacks under end posts.

(v) Jack down on to bearings.

SECTION 17.—RAMPS

Ramp lorries are not unloaded with the remainder of the stores; they should be backed up as near the tail of the bridge as possible and the stores used direct from the lorries to avoid double handling; the far ramps should be run straight over the bridge to the far bank.

As already stated, the decking level of the bridge is 2 ft. $3\frac{3}{4}$ ins. above the bottom of the baseplate. For heavy traffic conditions, a level ramp approach should be provided at each end of the bridge. If for any reason this is not possible, a maximum slope of 1 in 10 is permissible for Class 40 loads, and 1 in 20 for loads in excess of Class 40. Depth of excavation required for the baseplate and intermediate transom, with the allowable slopes of ramp, are given at Appendix E.

When a level or single span ramp cannot be provided, the intermediate transom will be 9 ft. 6 ins. from the centre line of the baseplate on the home bank, and 10 ft. 6 ins. on the far bank, where the end transom of the bridge is positioned in the end post. It is supported by four pedestals to prevent overturning.

Suitable types of grillage for the ramp pedestals, and end of ramps, also method of packing at mid-span for loads in excess of Class 40, are given in Chap. 8.

The amount of excavation required under pedestal supports and at the end of the ramp is shown in Appendix E.

SECTION 18.—WORKING PARTIES AND TIMES

1. The parties required for the construction of any bridge fall into the following four categories:—Panel, transom, bracing, and decking. The number and strength of each party varies with the length of bridge and type of construction. The main difficulty is in rolling the bridge forward, so that small working parties will need blocks and tackles, or some other mechanical aid, for launching.

Details of parties for single storey construction are as follows:—

Panel party	...	6 men (one man appointed I.C.).
Transom party	...	6 men (one man appointed I.C.).

Bracing party ...	N.C.O. I.C.	1
	Pin men	2
	Sway brace	4
	Transom clamps ...	2
	Rakers	2
	Bracing frames ...	4
	Tie plates	2
Decking party ...	N.C.O. I.C.	1
	Stringers	10
	Positioners	2

These figures give the normal composition of parties for constructing in fast time, but they can be increased when numbers are available. Similarly the bridge can be constructed with fewer numbers, bracing and decking parties being reduced first.

The number of parties required is as follows :—

Party	SS	DS	TS
Panel	2	2	4
Transom	1	1*	1*
Bracing	1	1	1
Decking	1	1	1

*For Class 70 decking an additional transom party should be used.

Alternatively.—Tasks can be allotted by sections. This is a better method, providing section strengths allow. At the bridge commander's " O " Group each section commander will be allotted a task, and if he requires reinforcement from another section it can be arranged there and then.

Suggested organization of parties using this method are given herewith. Section strength is taken as 1 N.C.O. and 10 men.

Double single construction

Party required :—4 secs. and adv. party.

Sec.	Task	Detail of jobs
1	L.H. girder	6 men panel party 2 men bracing frames 1 man rakers 1 man transom clamps } N.C.O. I.C. and pinman
2	R.H. girder	As 1 Sec.
3	Centre of bridge	6 men transom party 4 men sway brace } N.C.O. I.C.
4	Decking	(*a*) 2 men on each stringer. (*b*) All on chesses. (*c*) 4 men ribands—remainder footwalks.

Triple single construction

Party required :—6 secs. and adv. party.

Sec.	Task	Detail of jobs
1	L.H. girder	Each Sec.: 6 men panel party 1 man panel pins 2 men transom clamps 1 man raker — N.C.O. I.C.
2	R.H. girder	
3	Centre of bridge	As for D.S. construction.
4	Decking	As for D.S. construction.
5	Outer truss, R.H. side	6 men panel party. 1 man tie plates. 2 men bracing frames. 1 man panel pins.
6	Outer truss, L.H. side	As Sec. 5.

2. The following parties will be required for adding additional trusses to existing bridges :—

	*Panel carrying party	6 men.
	Panel positioning parties	8 men.
Bracing party	Panel levers	4 men.
	Bracing frames and top pins ...	2 men.
	Tie plates	2 men.
	Transom clamps and bottom pins ...	2 men.

* One panel carrying party can supply two positioning parties.

3. Times of construction will vary widely with conditions of site and working numbers available. Average times for double and triple single construction are given as a guide; these include off loading and layout of site.

80 ft. D.S. bridge ...	1 Platoon	3½–4 hrs. by day. 8 hrs. by night.
	2 Platoons	2½ hrs. by day. 4 hrs. by night.
110 ft. T.S. bridge ...	2 Platoons	4–6 hrs. by day. 7 hrs. by night.

Off loading lorries and laying out stores will take an average of 15 minutes per lorry by day, and 20 minutes at night. The figures are an average over the whole platoon; individual lorries will vary, and it is assumed that the carry will be less than 50 yds. No allowances for bankseats are made owing to the varying conditions of sites.

CHAPTER 5

ERECTION AND LAUNCHING—DOUBLE STOREY BRIDGES

SECTION 19.—GENERAL

Double storey construction is used to carry class 40 loads over spans greater than 110 ft., and class 70 loads over spans greater than 70 ft. It is also used in preference to single storey for longer and more permanent bridges.

The method of launching with skeleton launching nose and rollers remains the same. But here the principle to be observed is to keep the bridge back on the construction rollers as far as possible, and to launch after construction is complete ; rather than to feed the bridge forward a few bays at a time as with single storey construction. There may however be sites where this method is not possible, and the bridge will have to be pushed forward during construction ; the attendant difficulties will then have to be accepted. Again, it may be that the second storey has to be added to an existing single storey bridge *in situ*, in order to increase the load class.

The bottom storey of these bridges is exactly the same as in single storey construction except that no bracing is put on the top chord. Consequently the teaching in Chapter 4 will always apply, and only the method to be adopted for adding the second storey, together with such alterations to previous teaching as are necessitated by the increased launching weight, will be set forth in this chapter.

SECTION 20.—ROLLERS

The only difference between the roller layout here and that described in Sec. **6** for single storey bridges is that it is necessary for all double storey launching to add an additional pair of construction rollers 77 ft. away from the launching rollers. Also, double plain rollers will always be used at the 52 ft. position.

The need for additional rollers at 77 ft. is due to the sag in the tail of the bridge overhanging the 52 ft. rollers. This causes the bridge to " hog " between the 52 ft. rollers and the launching rollers, so that the 27 ft. rollers will be found to be taking no weight. They can therefore be taken out and inserted on prepared packing in the 77 ft. position, so that they are level with the launching plane. By this means the top chord of the bottom storey is kept as nearly level as possible throughout.

The tail of the bridge will have to be jacked up the required height in order to fit the 77 ft. roller on top of its packing ; for this purpose the toe of the jack is placed under the bottom chord of the panel directly beneath a panel vertical. If eight plain rollers

are available, the 77 ft. roller should be incorporated in the original layout.

Rocking rollers in double storey bridges will take 21 tons per roller, so that the maximum launching weight of bridge and nose will be 84 tons. Landing rollers will always be rocking rollers, but as the launching nose is of single storey construction, the limiting weight will be 15 tons per roller. Double rocking rollers will therefore be required in this position when half the weight of the bridge plus nose exceeds 30 tons. Clearly, when double launching rollers are required, part of the nose must be of double single construction.

SECTION 21.—CONSTRUCTION DRILL, DOUBLE DOUBLE BRIDGES

1. Method of construction on home bank before launching over gap.

(*a*) Construct launching nose as previously described when not more than eight bays long. If more than eight bays are required, the additional bays will be double single construction, with bracing frames added.

(*b*) Construct three bays of double single construction complete ; begin double storey construction at the head of the bridge with a separate party, bottom storey construction proceeding at the same time always two completed bays ahead.

(*c*) Move the bridge forward so that the front bay is over the rocking rollers ; it will not require to be moved again during construction unless with a long span the overhang of the tail beyond the 77 ft. rollers causes excessive sag in the bottom storey.

(*d*) Add panels to the first bay of double storey construction as follows :—

(i) Bring up panels each side of the bridge and rest them on the transoms of the bottom storey two bays behind where the panels are being added.

(ii) Pick up the base of the panel tilting it about the top chord of the bottom storey and slide it in towards the centre of the bridge to rest on top of the bottom storey.

(iii) Push inwards until the outside chord of the panel rests on the top chord of the outside truss of the bottom storey, and slide it along the bridge to within 6 ins. or so of its final position.

(iv) Lift the panel up, hingeing about its bottom chord, until vertically over the bottom storey. Slide the panel forward and engage the chord bolts to hold it in position—do not tighten fully.

(v) Repeat the process with panels on the inner trusses.

(vi) Position bracing frames on front verticals centrally on top chord of top storey and on rear verticals.

(vii) Tighten chord bolts and bracing frames.

(*e*) Add succeeding panels as follows :—

(i) Add two panels on top of outer and inner trusses in the manner described but after final positioning. the panel pins are inserted before the chord bolts are engaged.

(ii) Position bracing frames centrally on top chord and on rear verticals only.

(iii) Tighten chord bolts and bracing frames.

2. **Method of construction on restricted sites.**—When the bridge has to be fed forward over the gap before completion, the sequence of construction is exactly the same as that described in para. 1. The two main points for consideration are as follows : (*a*) at what point the bottom storey will be sufficiently level to permit second storey panels to be added ; and (*b*) how many bays back from the head of bridge the double storey work must begin, so that the bridge will not overbalance into the gap before the nose reaches the landing rollers :—

(*a*) As the bridge is fed forward over the gap the nose of the bridge sags below the launching plane which causes the bridge to " hog " over the construction roller. For this reason the top chord of the bottom storey will not be level throughout its length and difficulty will be experienced in fitting the top pins. The only point at which panels can be pinned together therefore, will be at the neutral point or point of contraflexure where the bottom chord is level, and adjacent to this where it is very nearly level.

It will be found that this point normally occurs between the launching roller and 27 ft. roller position, but as more weight is fed forward over the gap, the neutral point will move back along the bridge.

The panels, as already stated, can only be pinned together at this point. There is however no reason why panels should not be added to the top storey farther back along the bridge, being held by chord bolts and the bottom pins only, top pins being inserted when the panel reaches the neutral point.

(*b*) It is desirable to begin double storey work at the first bay of the bridge proper wherever possible. The limiting factor is the amount of construction that can be done before the bridge proper is fed forward over the gap ; *i.e.* the weight available behind the launching rollers for balance purposes. Thus, by taking moments about the launching rollers as the nose of the bridge is just arriving at the landing rollers,

and knowing the amount of construction that is possible behind the launching rollers, it can be established how many bays back from the head of the bridge double storey work can begin. Consider the 130 ft. D.D. bridge where only 80 ft. of construction can be carried out on the home bank :—

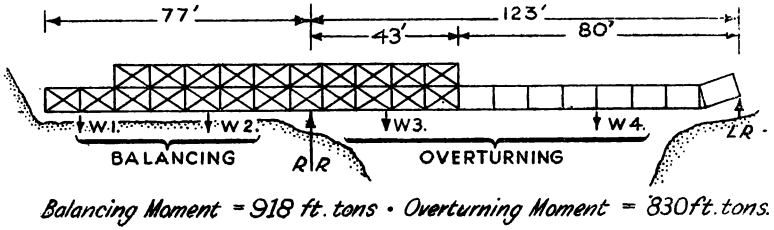


FIG. 5

This shows that double storey construction can begin at the head of the bridge. This statement assumes that panels are added to the second storey, and are left to have the pins inserted as described in sub-para. (*a*). Care will need to be taken against overbalancing at the earlier stages of the launch. Once the launching nose has landed, the work can proceed without difficulty, keeping two completed bays behind the single storey construction.

3. **Method of construction over the gap.**—Here, owing to the natural sag of a single storey bridge spanning over any gap, there is no position where the top chord is level. Consequently the sag of the bridge has to be removed by mechanical means, and it is for this purpose that the chord jacks are provided.

The method of erection is as follows :—

(*a*) Carry two panels to the centre of the bridge, and position them as already described over the CENTRE panel of the outer truss on each side of the bridge. Insert, but do not tighten, the chord bolts.

(*b*) Position two further panels similarly, but over the inner trusses on each side of bridge.

(*c*) Position bracing frames centrally on the top chord and on the panel vertical nearest the tail of bridge.

(*d*) Tighten up the chord bolts.

(*e*) Bring up four more panels, and position them on the outer truss both at the head and tail of the existing panels on each side of the bridge, inserting the bottom pin if Mk. I chord jacks are being used, and the top pin with the Mk. II chord jacks.

(*f*) Position four more panels similarly, but over the inner trusses on each side of the bridge.

(*g*) Position the chord jacks as described in Sec. 4, para. 2 (*c*), on the outer truss, over the joints to be completed. Adjust the positions of the panels by means of the screw jack until the pins and chord bolts can be inserted in the inner truss ; then, by slackening off slightly, the pins and chord bolts of the outer truss can be positioned.

(*h*) Position bracing frames on top chord and rear vertical.

(*j*) Tighten chord bolts and bracing frames.

(*k*) The same sequence is then followed for the remainder of the bridge, work going on towards the head and tail of the bridge simultaneously.

The following general points should be noted :—

(i) Bracing frames and chord bolts must be fully tightened on the previous bay before the jacks are operated to form the next joint.

(ii) Not more than three men must operate the ratchet lever of the screw jack, nor must it be lengthened in any way to give extra leverage. If it is found that three men are unable to operate the jack, a second jack must be fitted on the adjacent truss to give extra force.

SECTION 22.—CONSTRUCTION DRILL.—TRIPLE DOUBLE BRIDGES

Triple truss double storey construction can be done by any of the three methods described for double double work, and in exactly the same way. With triple single construction, however, the second truss must be kept one bay ahead of the inner and third trusses in order that the pins may be inserted correctly. Thus, when both storeys are being constructed simultaneously, work will be in progress on four bays of the bridge with two completed bays of single storey between as shown below :—

Bay 1 : Panels added to second truss lower storey.

Bay 2 : Construction completed lower storey.

Bays 3 and 4 : Two bays complete single storey bridge.

Bay 5 : Panel added to outer truss upper storey.

Bay 6 : Construction completed upper storey.

Pins in the top storey of triple double bridges are best inserted from the inside of all trusses ; thus the outer truss panel will be positioned first, followed by the second and inner trusses. This process can be repeated for each bay in turn.

End posts are fitted to the bottom storey as described for triple single bridges (Sec. **14**, para. 8).

The bracing of the upper storey consists of bracing frames in the centre of each bay between the inner and second trusses, and also on the panel verticals nearest the tail of the bridge. Tie plates are

fitted to the top and bottom storey, using the front verticals in the bottom storey and the front verticals in the top storey. It will not be possible to fit tie plates to the front bay of the bridge on the top storey, the raker holes being occupied by a bracing frame.

SECTION 23.—LAUNCHING

1. Details of the length of launching nose for the various spans of double double and triple double bridges are contained in Plates XVIID and XVIIE; it will be noted that double truss construction is used in the nose when this exceeds eight bays in length with double double bridges, and six bays with triple double bridges. Bracing frames must be fitted to all double single nose construction; otherwise, the same skeleton construction is used as previously described.

2. In considering the levels of rollers, when the calculation is made as described in Chapter 4, it will often mean that an uphill launching plane has to be chosen and that some mechanical assistance will be required to launch the bridge. Also if the slope is at all great it may be necessary to anchor the bridge, in order to prevent it from running back on the rollers during construction. When using a restricted site therefore, which involves pushing the bridge forward after every few bays have been added, it may be better to choose a level launching plane, gaining as much height as possible by the use of the launching nose links. Mechanical help will then only be required to clear the rising portion of the nose over the launching rollers, and construction will be speeded up considerably.

It should also be ensured that when the bridge is at its point of balance, the nose will be a few inches clear of the landing rollers. Thus, when the nose does come down, the centre of gravity will be forward of the launching rollers. There will then be no fear of the bridge riding clear of the launching rollers between the 27-ft. rollers and the landing rollers. The allowance of 6 ins. for error which is made in all launching calculations, will cover this contingency.

3. Where mechanical aid is required for the launch, the most likely sources to be available are as follows:—

(*a*) 3-in. heavy gyn tackle with 100 fms. 3-in. fall and 6-ft. S.W.R. strops.

(*b*) Winch lorries.

(*c*) Bulldozer or angledozer.

4. The first of these is part of the standard Bailey equipment, and should be all that is normally required. The method of applying the power for launching should follow the general lines given below.

(*a*) As previously mentioned, the blocks should be anchored as near to the line of the bridge as possible, and attached to the end of the nose panels by passing the strop behind the

panel pin in the female jaws of the leading panel. The majority of the launching party should then apply the power on the far bank, the remainder pushing on the tail, and keeping the bridge straight by swinging the tail if necessary. As the nose passes the landing rollers, the strop is transferred to one of the panel verticals farther along the nose, the tackle being overhauled for this purpose. Using a heavy gyn tackle, one man can exert a pull of 300 lb. on the bridge.

(*b*) As it is unlikely that it will be possible to get a winch to the far bank, it will be best positioned either to one side of or directly behind the bridge, and its pull transferred through an anchored snatch block to give it the required direction. The cable can readily be passed underneath the bridge along the centre line, and attached to the tail of the bridge by means of an S.W.R. sling passed round the verticals of panels on each side. The pull should not be applied to a transom at its centre, because the transom clamps will fail. The average pull for winches fitted in 30-cwt. and 3-ton lorries is 4 tons. The limitation is the strength of the wire rope.

(*c*) The best use of bulldozers or angledozers is to give a direct push at the tail of the bridge. Power should not be applied to a transom unless it is supported in the end posts. It will not normally be so supported at the beginning of the launch, because the end post projects below the bottom chord of the bridge and will push the rollers over. Consequently, two bulldozers pushing along each main girder are best. One can be used to push on one side only, provided care is taken to ensure that the bridge is pushed straight along its centre line. The approximate horizontal push developed by different types of bulldozer is shown below :—

Class	Max. push developed
4	3·5 tons
3	6·5 tons
2	9·5 tons
1	11·75 tons

With both the methods described in (*b*) and (*c*) heavy gyn preventer tackles must be rigged and attached to each side of the bridge, so that it can be fully controlled throughout the launch and speedily checked when necessary.

As an example, the horizontal push required to launch a 120 ft. double double bridge up a slope of 1 in 15 is 6½ tons.

SECTION 24.—WORKING PARTIES AND TIMES

1. Parties for the construction of the bottom storey remain as in Sec. **18**, the following additional parties being required for the construction of each truss of the upper storey :—

Panel carrying parties ... 6 men.
Panel positioning parties ... 7 men (including 1 pin man).
Upper bracing parties { Bracing frames, 3 men. / Chord bolts, 2 men. / Tie plates, 1 man.

The number of parties required for the construction of double storey bridges using the drill described will be as follows :—

PARTIES

Party	Lower panel	Transom	Lower bracing	Decking	Upper bracing	Upper panel carrying	Upper panel positioning
Double Double	2	1*	1	1	2	2	2
Triple Double	4	1*	1	1	2	2	2

* Transom parties should be increased to two for Class 70 decking.

Alternatively the following tables contain suggested allocation of work using the section task system :—

Double double construction

Party required :—8 sections and advance party.

Sec.	Task.	Detail of jobs
1, 2, 3 and 4	As for D.S. construction	
5	Carrying party L.H. upper storey.	Panel party : 6 Spare 4.
6	Carrying party R.H. upper storey.	As 5 Sec.
7	Positioning party L.H. upper storey.	Panel party : 6 Pin man : 1 Bracing frames : 3 Chord bolts : 2 (from 5 Sec.)
8	Positioning party R.H. upper storey.	As 7 Sec. Chord bolt men from 6 Sec.

This leaves two men spare in both 5 and 6 sections who can act as reliefs one for each of the panel carrying parties in 1, 2, 5 and 6 sections, or who can be used to strengthen the chord bolt parties.

Triple double construction

Party required :—10 sections and advance party.

Sec.	Task	Detail of job
1, 2, 3, 4, 5 and 6	As for T.S. construction.	
7 and 8	As 5 and 6 for D.D. construction.	
9 and 10	As 7 and 8 for D.D. construction.	Pins inserted from inside for all panels.

Spare men from 7 and 8 sections used as in suggested double double organization.

Advance parties can be found from those sections of construction parties that will not be required until building has been in progress for some time ; alternatively, a separate advance party can be used, who can join the sections working on approaches at the conclusion of their job.

2. The following parties will be required for each girder when adding the second storey to an existing bridge :—

2 panel carrying parties of 6 men.
2 panel positioning parties of 6 men (including 1 pin man).
2 bracing parties { Bracing frames, 3 men. / Chord bolts, 2 men. / Tie plates, 1 man.
2 chord jack parties of 4 men.

3. **Times of construction.**—The following times for double storey bridges are based on working parties as described above. They include for offloading and layout of site. Bankseats are not allowed for.

130 ft. double double bridge—7–9 hrs. by day, 10–12 hrs. by night.

150 ft. triple double bridge—10–12 hrs. by day, 14–16 hrs. by night.

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CHAPTER 6

ERECTION AND LAUNCHING TRIPLE STOREY BRIDGES

SECTION 25.—GENERAL

1. Triple storey bridges are required to carry Class 40 loads over spans in excess of 150 ft. and Class 70 loads over spans in excess of 110 ft. They can be either double or triple truss, each of which can be built in two ways as described below :—

(*a*) In the first method the deck is carried on the bottom storey panels, so that the bridge is three storeys high, and special overhead bracing is provided for the top storey panels as described in Sec. **26.**

(*b*) In the second method the deck is placed at one-third height, that is on the second storey panels, and the bottom storey is underslung. Bracing is fitted in accordance with Sec. **26** below.

2. In both the above methods of building, the bridge is supported on end posts which are fitted to the storey at ground level only ; the end bay of panels of the top or underslung storey can also be omitted.

3. The load class of the bridge is not affected by the position of the decking, or the omission of the panels. Maximum spans for different load classes with double triple and triple triple bridges are given in Table 1. Where the maximum span of the normal type of construction described above is not sufficient for any particular gap, an additional 30 ft. span of double triple and 10 ft. span of triple triple bridge can be obtained for Class 70 loads by the adoption of a " special " form of construction. This method involves the use of the crib capsill and crib bearing to support the bridge 10 ft. in from each end and is fully described in M.E., Vol. III, Part IV. Special care must be taken with the packing under the end transom of the overhanging portion when this type of construction is used. No increase of span for Class 40 loads and below can be obtained by this method.

4. The maximum load that can be carried by the launching rollers remains at 21 tons per roller, and not more than 7½ tons can be carried on the toe of existing jacks. Owing to these weight limitations, on some occasions these bridges will have to be constructed and launched as double storey bridges, and the third storey added over the gap.

SECTION 26.—BRACING—SPECIAL PARTS

Additional bracing, as well as that previously described for double and triple truss bridges, is required on top of the third storey panels when the decking is supported by the bottom storey

panels. This takes the form of ordinary Bailey transoms and sway braces in every bay of the bridge. In order to give adequate headroom, these are accommodated in special overhead bracing supports (Sec. 3, para. 2 (*d*)) giving a clearance of 14 ft. 6 ins. from deck level.

The overhead supports are used one per girder on each bay of the bridge, and are fixed to the panels of the inner and second truss by means of chord bolts. They should be positioned by using the chord bolt hole nearest to the female lugs of the panel, where they will not interfere with the positioning of the bracing frames on the top chord of the bridge. By this means, supports will be provided at 10 ft. intervals throughout the bridge.

If the special supports are not available, overhead bracing can be provided by using the panels of the top storey upside down.

Transoms are then held in the normal seating by transom clamps, and sway braces are positioned, using the recesses which will now be in the top chord of the reversed panel. One transom and one set of sway braces are used in every bay except the two end bays. Headroom is reduced to 12 ft. 2 ins.

No overhead bracing is required when the bottom storey is underslung, but bracing frames are required on the bottom chord and rear verticals, and tie plates on the front verticals, of the underslung panels. Transoms and sway braces are not necessary in the underslung storey except in situations where winds in excess of 50 m.p.h. are normal. If such a wind is experienced, and no bracing is fitted, the bridge must be closed to traffic.

SECTION 27.—LAUNCHING AND CONSTRUCTION

1. Double triple bridges

(*a*) When the deck is supported on the bottom storey panels, up to 200 ft. span of bridge can be launched complete except for parts of the decking, etc., as detailed in Plate XVIIF. Over 200 ft. span the bridge must be launched as double double, the make up being in accordance with Plate XVIIF. Six jacks will be required for all spans of double triple bridge. Four will fit under the end posts, and two can be either under a transom in the end post, or under the centre vertical of the end panel.

b) When the bottom storey is underslung, the bridge is first launched as double double for all spans, the bottom storey being added over the gap. This method is better than launching complete for spans up to 200 ft., which would involve jacking down through a distance of approximately 6 ft. at one end of the bridge.

2. Triple triple bridges.—As the smallest span of bridge required will be 130 ft., Class 70, the method to be adopted for all triple triple bridges will be to build and launch as triple double, and either add the top storey or undersling the bottom storey with

the bridge in position over the gap. The maximum span of triple double bridge that can be launched by standard methods is 200 ft. Spans over 200 ft. must be launched as double double and converted to triple double and then to triple triple over the gap, or alternative methods of launching must be used.

SECTION 28.—ERECTION METHODS

1. When the deck is supported on the bottom storey panels, the problems for both double triple and triple triple bridges are the same —

(*a*) Method of positioning the panels of the top storey.

(*b*) Method of fixing overhead bracing supports and transoms.

2. If the Coles crane lorry is available for use, a single truss, five panels in length, can be erected on the ground, or on the deck of the bridge, and hoisted into position on the top storey as a single unit. The maximum lift of the crane, working at its minimum radius of 7 ft. 9 ins. will be 11 ft. 5 ins. from wheel level to the underside of the panels. The height of the top chord of the second storey panels on top of plain rollers placed directly on the ground is 10 ft. 10 ins. Where the packing under the rollers increases the height to which the panels must be raised, beyond the lift of the Coles crane, it will be quicker to launch the bridge as a double storey, and add the top storey from the deck of the bridge after jacking down.

No difficulty should be encountered in fixing the panels with the chord bolts, or in joining the sets of panels.

When the crane is not available, panels can be manhandled on to the top storey either direct from the lorries or from the deck, in the following manner. Lorries are positioned either at the side of the bridge, or on the deck, when the lift will not be so great. The first panel is stood on end, and lifted, pivoting about the centre vertical of the panel and the top chord of the second storey, so that it lies flat on top of the second storey panels at right angles to the existing trusses. It is then lifted into a vertical position pivoting about its bottom chord, and turned through 90 degrees so that it is parallel with the trusses. It can then be skidded along, and connection made with the existing panels as described for double storey bridges. Chord jacks may be required to make the pin joints, depending on the span of the bridge. A party of eight men, with some help from two others on top of the inner truss of the bottom storey, can carry out the operation successfully. When using this method from lorries the panel lorry loads must be adjusted on the site to allow room for the working party.

The davit can also be used to position the panels of the top storey, being positioned on the bottom chord of the second storey panels. It is considered that this will be the slowest of the three methods described.

A further method is to construct false decking. This may take the form of one or two bays at each end of the bridge on the bottom

chord of the second storey. Stores are split to each end of the bridge and lifted on to top storey by means of the false decking. The economic distance through which panels can be skidded forward is probably about three bays, so that in long bridges additional bays of false decking will have to be provided.

With triple triple bridges the direction from which pins are inserted in the trusses of the top storey will vary with the method adopted for positioning the panels. When the panels are positioned, either by the Coles crane, or direct from lorries, from the inside of the bridge, the outer truss will be fixed first, and all pins will be inserted from the inside. If, on the other hand, the crane or lorry is positioned on the ground alongside the bridge, the inner truss will be fixed first, pins will therefore be inserted from the inside on the inner truss, and from the outside on the remaining two trusses.

When double storey bridges exceeding 210 ft. span are launched as a basis for triple storey bridges, neither the Coles crane nor a loaded lorry may be taken on to the deck. Tripling up must be done by carrying the panels on to the bridge and hoisting them into position either by manhandling or with the aid of the davit.

3. The overhead bracing is best lifted into position as separate units and assembled on the top chord. The overhead bracing support can readily be lifted with the aid of a lashing, and three men hauling from the top storey. It can then easily be skidded into its final position over the chord bolt hole nearest the female jaw of the panel. The supports should only be bolted to the girder on one side of the bridge at this stage, as when the transom is positioned it will be found that the bolt holes do not register on the other girder, due to the girders of the bridge leaning in slightly towards the centre.

Transoms can be lifted on to the top storey either by means of the Coles crane working on the deck of the bridge, or by manhandling. The simplest method of manhandling the transoms up is to erect a temporary staging of two transoms and a few chesses on top of the second storey panels; the transoms can then be lifted up to the top storey in two lifts. The staging can easily be moved along bay by bay, if the overhead bracing is carried out at the same time as the panels are fitted. If the bracing is left until the girders are completed, the staging need not be moved, as the transoms can be rolled along the top chord to the required position.

When the supports for the first transom have been lifted on to the top chord the assembly and fixing of the overhead bracing proceeds as follows: lift up the transom, position it on the seating, and fix it using the four clamps on the support. Lift up a jack, and fix it so that the toe is against the stiffener of the support, and the foot against the top chord of the second truss of the girder. Two or three strokes of the jack lever should force out the girder sufficiently to enable the chord bolts to be inserted through the support and the top panels. Finally, tighten up the chord bolts.

After the first set of overhead bracing has been positioned in this manner, there will not normally be any difficulty in fixing the remaining transoms and supports.

Swaybracing is fixed in every bay, but should not be tightened until the transom has been fixed in the next bay ahead.

4. When the bottom storey of the bridge is underslung, the best method of construction is as follows: After the double storey bridge has been built and launched, plain rollers are laid 9 ft. 6 ins. from the centre line of the existing bridge, the front roller being 3 ft. 6 ins. from the baseplate position and another one 27 ft. behind that. A single truss girder is then constructed on the rollers equal in length to the number of bays of panels required to make up the bottom storey of the bridge, provided that this does not exceed twelve. Rakers are attached to the bottom bracing frame hole of the inner panel verticals, one per bay, and laid flat across the bottom chords of the panels so that they project beyond the side of the bridge and over the gap. The truss is then launched by sliding over the rakers, and is steadied by men standing on the bottom chord of the existing girder. Meanwhile 6 ft. long 9 ins. by 4 ins. timbers are placed on the top of each girder. These are held in place by chord bolts, the chord bolt hole nearest the female jaws being used to fix them, and are placed one to every three panels, *i.e.* first, fourth, seventh, etc. Two-two or three-three lifting tackles are then suspended from each timber, one at the outside end, and another between the inner and second trusses of the existing bridge. 9 ins. by 3 ins. timber is strong enough to do this job, provided that 1 in. of packing is placed between it and the panel chord, so that the chord bolts can be properly tightened.

First the outside tackles are connected with the single truss which is resting on the rakers. This is then lowered until its top chord is below the bottom chord of the existing girder.

It is then pulled in towards the centre of the bridge, and the weight taken by the inside tackles; these are connected to it by a sling which passes through the panel of the inner truss of the existing girder, under the top chord of the single truss, and back to the hook of the tackle. When the outside tackle has been disconnected, the truss is pulled into line with the inner truss of the existing girder, and lifted up so that the chords are in contact.

Chord bolts are inserted, and tightened to fix the truss in position. The process is then repeated to fix the bottom storeys of the second and third trusses.

It is more convenient, when using this method, to keep the number of panels in the truss launched over the rakers to a minimum. This can be achieved by launching half the lower trusses of each girder from each end of the bridge.

This method generally has the additional merit that it can be used whilst the bridge is still open to traffic.

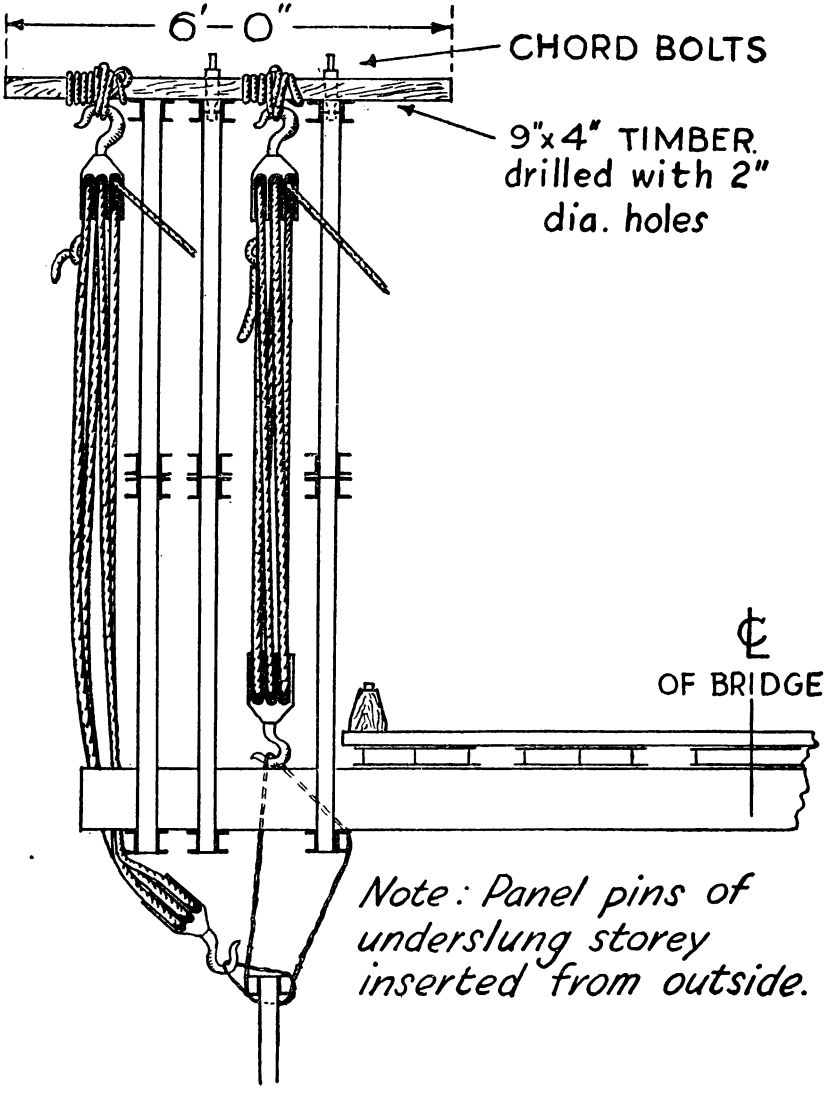

6'-0"
CHORD BOLTS
9"x4" TIMBER drilled with 2" dia. holes
℄
OF BRIDGE
Note: Panel pins of underslung storey inserted from outside.

FIG. 6

SECTION 29.—WORKING PARTIES AND TIMES

Insufficient practical experience has yet been gained of this type of bridge to be able to give reliable times for construction. The following figures are only given as a rough guide of the time to add the top storey, after the triple double bridge has been built and launched.

(*a*) Time to add top storey per bay, triple triple bridge.

(i) With Coles crane : 25–30 minutes per bay.
(ii) Manhandling : 35–40 minutes.
(iii) With davit : 45–50 minutes.

(*b*) Time to undersling bottom storey.

Launching as separate truss : 35 to 50 minutes per bay. No figures for working parties are given, since these will depend on the method employed.

CHAPTER 7

VARIATIONS ON STANDARD PRACTICE

SECTION 30.—ALTERNATIVE METHODS OF LAUNCHING AND BUILDING

1. **General.**—The intention of this chapter is to give brief notes on some of the methods that have proved of practical value in overcoming difficulties arising in the field, when parts of the standard equipment are not available. These methods, which are described in the following paragraphs, are :—

(*a*) Cantilever launch, using launching tail.

(*b*) Launching by rolling out on falsework.

(*c*) Launching without rollers.

(*d*) Use of girders without endposts.

(*e*) Broken span bridges.

(*f*) Launching girders separately.

Bailey bridges can be launched by the derrick and preventer method, or by floating out on falsework. These methods are suggested as alternatives for 210–230 ft. triple triple bridges which can only be launched as double double by the standard methods. The standard practices for other types of bridge when using this method of launching apply equally well to Bailey bridges.

2. **Cantilever launch, using launching tail.**—Bridges up to 80 ft. span double single can be launched by this method. The tail is constructed behind the last bay of the bridge. and is of the same skeleton construction as a launching nose. Landing rollers are not required, the bridge being lowered directly on the bearings on the far bank. The following points should be noted in connection with this method :—

(*a*) The bridge must always be launched undecked.

(*b*) Counterweight will be required on the last bay of the tail, to balance the weight of the bridge over the gap. This is calculated from moments about the launching rollers.

(*c*) The total weight of bridge (less decking), plus tail and counterweight, must not exceed the permissible load on the launching rollers.

(*d*) The levels of the launching and construction rollers must be adjusted to allow for difference in height of the banks and the sag at the head of the bridge.

(*e*) End posts should be fitted direct to the head of the bridge. Remember that these will project below the bottom chord, and therefore allow extra height for them to clear the bearing.

3. **Rolling out on falsework.**—This operation presents no great difficulties provided the rollers are spaced at the normal 25 ft. intervals to limit the amount of sag in the bridge. Even at this spacing the sag will amount to 2 ins. or 3 ins. on a double single bridge, which will necessitate the head of the bridge being jacked up as it passes each roller position, so that the rollers can be inserted under the bottom chord. Cribs must be sufficiently wide to resist any tendency to overturn as the bridge is pushed forward. No nose or tail will be required.

4. **Launching without rollers.**—Bridges up to 40 ft. span single single can be launched without the use of any rollers, using the cantilever method. A set of greased timbers, or two greased stringers, are placed each side of the centre line, and as near the gap as possible, with another set placed 20 ft. behind the first, on which the bridge is skidded forward.

The four bays of bridge proper must be of skeleton construction, using only one transom per bay, but fully braced. Two bays of tail are built with two transoms per bay, and one bay of stringers is placed on the last bay as counterweight.

The bridge can then be cantilevered over the gap and lifted into final position by manpower, with the aid of handspikes.

5. **Use of girders without end posts.**—The number of end posts available may not be sufficient when several small span bridges are built from one set of equipment. Bridges of single storey construction can, however, be supported by timber packing directly under the end verticals of the end panels. Limiting spans for different load classes when using this method are given in Table 2.

TABLE 2

Limiting spans for girders without end posts and no additional panels

Construction	Class	9	12	18	24	30	40
S.S.	Max. span in ft.	90	80	40	20	20	
D.S.		150	140	100	90	80	60
T.S.		170	160	140	140	120	100

The transoms supporting the ends of the first bay of stringers are normally carried in the front end posts. Some forms of support for this transom will therefore be required in this type of construction. Support can be given by either of the following methods :—

(*a*) By supporting the transom on ramp pedestals and adequate packing, outside and independent of the bridge proper.

It is positioned so that the projecting ends of the stringers rest on and engage with the lugs of the transom in the usual manner, as do the ends of the ramp bay.

(*b*) By adding one extra panel to the inner trusses on each side of bridge, and placing the transom in the seating nearest the bridge proper. The ends of stringers and ramps are then supported on this transom. A vertical bracing frame should be placed between the two trusses at the end of the bridge proper, and a raker between the additional panels and the transom. Packing is extended for 2 ft. on each side of the panel joint with this method.

In both the above solutions the transom will require packing at the centre for loads over Class 24. The packing should be dug in so that a minimum ramp slope is obtained ; a 10-ft. span level ramp should be made wherever possible.

If the additional panel mentioned in para. 5 (*b*) above is added to all the trusses of the girders, then the bridge can be of the sam load class as it would be if end posts were fitted.

6. **Broken span bridges.**—A broken span bridge is the term used to describe a bridge which is composed of a series of independent short spans resting on intermediate supports. The supports may be either piers of an existing demolished bridge, or Bailey cribs erected in the gap.

By using special parts, it is possible to launch over rollers on the existing piers as one complete bridge. This can be then broken into the required numbers of short spans between the piers.

The parts involved are :—

(*a*) Span junction posts.

(*b*) Junction link.

(*c*) Junction link bearing.

These parts, and the method employed in launching and breaking spans, are fully described in M.E. Vol. III, Part IV. Details of suitable Bailey cribs can also be found in this book.

7. **Launching girders separately.**—If the parts required to launch as a " broken span bridge " are not available, launching over a number of piers can be carried out as follows :—

Launch and deck down the first span by the normal method ; the second span is then boomed out through this span as single girders, which are then skidded into position and connected by transoms. This span is then decked and the process repeated over any number of piers.

This method can also be used to repair a multiple span Bailey bridge where one of the middle spans is damaged.

Similarly, it may be used to launch the landing bay of a Bailey pontoon bridge (Sec. **38**) when an approach span on to a crib pier has been launched from the bank ; a method which might be used

on a wide tidal river with gently shelving banks, in order to reach deep water.

The sequence of construction is to assemble a double single Bailey girder on the deck of the existing bridge. It should be twice as long as the gap, and should have end posts on the nose, also bracing frames on the top chord, and on the rear end verticals of each panel. The girder is launched over rollers and cut off at the correct length by removing the panel pins. End posts are fitted to the rear panels, and it is skidded into position. The remaining tail is then skidded to the other side of the existing span, and used to form the front half of the second girder which is launched in the same way. Sway bracing, transoms, rakers, stringers, and chesses are added to each bay in that order. Jacking down and removing the greased packing completes the operation.

CHAPTER 8

END OF BRIDGE AND RAMP SUPPORTS

SECTION 31.—GENERAL

1. No bridge, however well designed, can carry heavy loads successfully unless adequate provision is made to support the ends of the bridge at the bank-seats. Although special baseplates are provided with the Bailey bridge, it will frequently be necessary to provide additional grillage in order to spread the load over a greater area. The amount of grillage required depends on two factors :—

(*a*) The maximum reaction at each baseplate.

(*b*) The safe bearing pressure of the ground.

2. **Maximum baseplate reactions** for various load classes and spans of bridge are given in Appendix B. These are the total reactions made up of dead weight of bridge plus maximum live load reaction. In calculating the live load reaction the following assumptions are made :—

(*a*) The type loads for the class in question are placed in the position to produce maximum reaction.

(*b*) An allowance for unequal distribution of load between girders is made as described in Note 4 to Table 1, M.E., Vol. III, Part I, 1941.

(*c*) No addition is made for impact, owing to the short duration of this effect coupled with the resilience of the ground, and its consequent power of recovery from instantaneous overloads.

3. **Bearing pressure on ground.**—The safe bearing pressures for various types of ground are given at Appendix B.

SECTION 32.—STANDARD TYPES OF GRILLAGE

Where the bearing pressure under the baseplate exceeds the safe bearing pressure of the ground, it is necessary to provide a grillage to spread the load over a larger area. In order to distribute the load efficiently the grillage itself must be sufficiently strong and stiff to resist the bending moments and shear force induced in it.

The standard grillages described below are calculated on the following basis :—

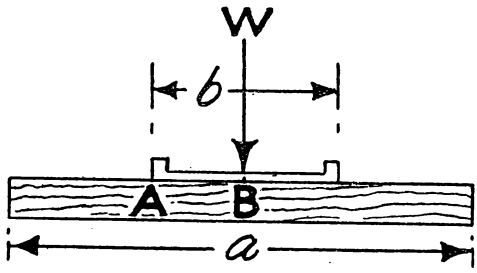


FIG. 7

$$\text{Maximum shear force (at A)} = \frac{W}{a}\,\frac{(a-b)}{2}$$

$$\text{Maximum bending moment (at B)} = \frac{W(a-b)}{8}$$

Where a common grillage is used to support both the rocking rollers for launching and the baseplate, it is usual to place the centre of the latter 1 ft. 3 ins. from the centre of the grillage, the centre line of the rocking rollers being 3 ft. 6 ins. from the baseplate. This eccentric loading produces unequal distribution of pressure below the grillage, so that the maximum intensity is considerably larger than the average pressure produced by a centrally loaded grillage of the same area. Details of the construction of the four standard types of grillage are given at Appendix C, together with variations of type G to be used according to the availability of ramps or timber and the bearing area required on the ground. The bearing areas given for the different types have where necessary been adjusted to allow for the unequal pressure distribution. The necessary setting out dimensions for the excavation required for the different types are given at Appendix E. The use of these grillages for different spans and conditions is given in Appendix D.

As the Bailey Bridge can rapidly be built for a low load class, and later converted *in situ* to a higher class, the type of grillage to be provided for the original bridge must be very carefully considered. Considerable time will be wasted in the conversion of the bridge if a new and heavier type of grillage has to be substituted.

SECTION 33.—END TRANSOMS SUPPORT

For bridges over Class 24 the transom at each end of the span must be supported at its centre. The reaction on the support may be of the order of 15 tons in the case of Class 40 bridges and up to nearly 20 tons for Class 70. The packing provided must distribute these loads over a suitable area, according to the bearing pressure of the ground.

SECTION 34.—SUPPORTS FOR RAMPS

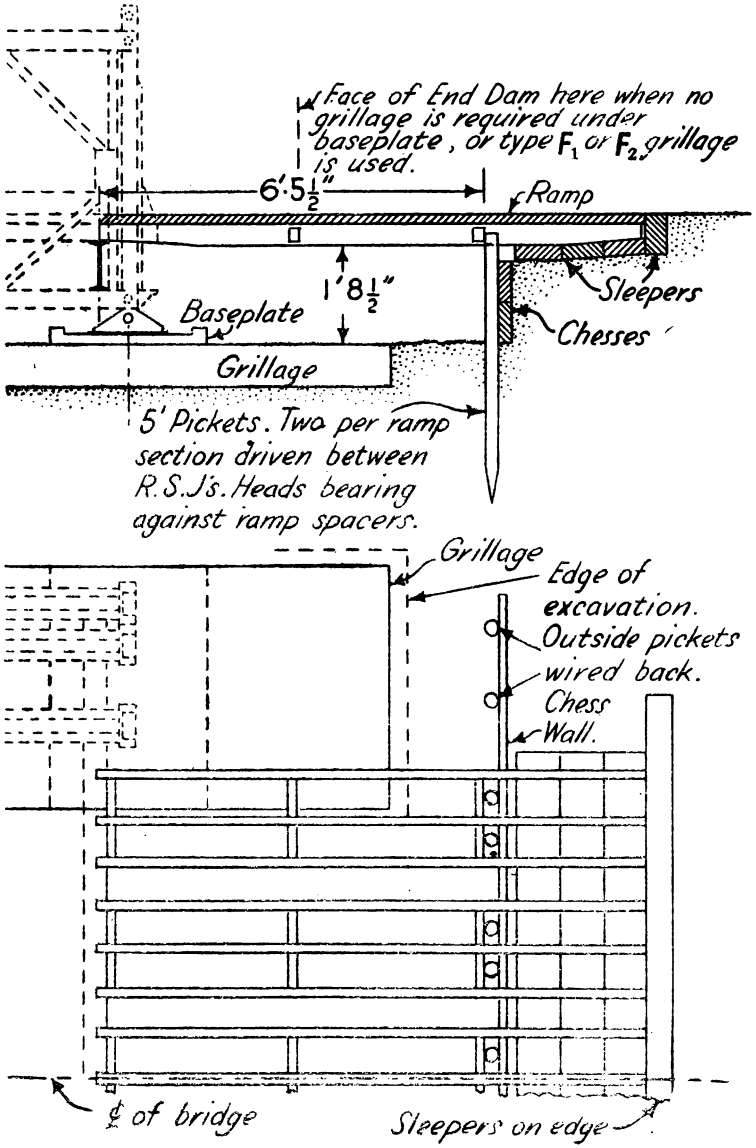
For loads up to and including Class 40, the ends of the ramp sections will be adequately supported by a length of 9-in. by 3-in. timber laid for the full width of the ramp bay. For loads in excess of Class 40, three lengths of timber laid side by side under the tapered section at the end of the ramp and continued for the full width, will be required.

When two or more ramp bays are provided the pedestals which carry the transom at the junction require support. On soft ground 6-ft. lengths of 9-in. by 3-in. timber should be used, three under each pair of pedestals. All four pedestals can be positioned within the width of the roadway, or as shown in Plate XX.

For bridges over Class 40 each ramp section must be supported at its mid point. The simplest method of overcoming this difficulty is to provide one level 10-ft. ramp bay at each end of bridge as shown in Plate XI. If this method is not adopted, the packing at the mid span points must be capable of withstanding a maximum reaction of up to 36 tons with Class 70 loading.

PLATE XI

10 Ft Ramp at tail of Class 70 Bridge



CHAPTER 9

MAINTENANCE AND REPAIRS

SECTION 35.—MAINTENANCE

The bridge requires very little maintenance, either on transport or when erected. The chief parts requiring attention are the erection tools.

1. **On transport.**—The following parts should be kept clean and greased :—

Panels—jaws, and the insides of all holes.
Panel pins.
Bracing frames, rakers, tie plates—the conical dowel.
All bolts and screw threads.
Rollers.
Jacks, chord jacks, and pin extractors.
Levers.
End posts and bearings—the curved bearing surfaces and insides of pin holes.

2. **In bridge.**—The maintenance party normally required for a Bailey bridge will be one section of a field company platoon. The main points that they will have to watch will be as follows :—

(*a*) Check that all bracing bolts, chord bolts, transom clamps, and sway braces are and remain fully tightened.

(*b*) Examine baseplates and grillages periodically, and check that there is no *uneven* settlement. Check that packing under end transoms and ramps remains tight.

(*c*) Check that there are no chesses splitting or warped, and bearing unevenly. Provide timber wearing surface if the bridge is to be in position for any length of time.

(*d*) Grease round all pins to prevent water from entering the joints ; also bracing bolts and any exposed threads. Check carefully that no rusting occurs.

SECTION 36.—ASSESSMENT OF DAMAGE IN TERMS OF REDUCTION OF LOAD CLASS

The effect of damage to any particular member on the load carrying capacity of a bridge will largely depend on the position of that member in the bridge. For instance, damage to the panel chords, which take the bending stresses, will be most serious if it occurs at the centre of the bridge where the bending moment is a maximum. Similarly, the effect of damage to verticals and diagonals which take the shear stresses is most severe in the end bays of bridge. Photographs of typical damage are given at Plate XXXV.

The effect of damage to bracing members and decking will be approximately the same in all parts of the bridge, but since these are very easily replaced, they will not be considered here.

The method of determining the effect of particular damage to any member is to compare the stress that the damaged member is still capable of taking with the stress that that member has to take because of the position in the bridge. For simplicity, both the strength remaining in the member and the stress that it should be capable of taking are expressed as a percentage of the total strength of the member when undamaged. A comparison can be made of the strength remaining in a member given for various types of damage in Plate XXXIII and the load that it should be capable of carrying which is given in Plates XXXIVA and XXXIVB for various positions in the bridge.

It follows, therefore, that if the percentage strength remaining is greater than the percentage stress it has to bear, all will be well, and no reduction of load class is necessary. When, on the other hand, the percentage of stress to be taken is greater than the percentage of strength remaining, the load class must be reduced, as shown in the examples given later.

The two main girders of a bridge are considered independently of each other ; therefore if one side is damaged, and not the other, no allowance in strength must be made for the fact that one side is undamaged. But in each girder which consists of one or more trusses, *e g.*, triple truss bridge, the three chords are considered to act as one ; therefore if one chord is damaged so that its strength is reduced to 50 per cent. of its original, the girder will in effect have two chords of value 100 per cent. and one chord value 50 per cent., so that the remaining strength of the girder as a whole will be $\frac{250}{3}$ *i.e.*, 83 per cent. The same ruling will apply to panel verticals, *e.g.*, damage to one vertical, reducing its value to 15 per cent., with a triple double bridge results in the value of the girder as a whole being reduced to $\frac{515}{6}$ *i.e.*, 86 per cent. of its original strength. Complete severances of a panel vertical in a single truss bridge reduce the shear value at that section to zero. Taking diagonals ; at any vertical section through a panel, there are two diagonals resisting the shearing forces ; in a double single bridge, if one diagonal is completely severed the remaining strength will be 75 per cent. Complete severance of both diagonals at any vertical section of a single truss bridge reduces the strength to 30 per cent. because the stiffness of the chords takes a certain amount of the load.

In double storey bridges it can be assumed that all bending stresses are taken by the top and bottom chords. Damage to the intermediate chords can therefore be ignored provided that any damage to the adjacent shear members is allowed for as previously described.

With triple storey bridges, if the intermediate chords are damaged, so that the residual strength is at least 50 per cent., then the damage

can be ignored subject to damage to shear members as for double storey bridges. If the residual strength of the intermediate chords is reduced below 50 per cent., then the strength of the girder as a whole as calculated for any damage to the top and bottom chords must be reduced to three-quarters of that value. For instance, if damage has been sustained by the top and bottom chords, so that the value of the girder would be 80 per cent. assuming no damage to the intermediate chords. If the intermediate chords are also damaged so that their residual strength is reduced to below 50 per cent., then for the same damage to the top or bottom chord, the value of the girder as a whole will be reduced to $\frac{3}{4} \times 80$ or 60 per cent.

If any bridge member is struck by flying metal and is deformed but not severed or holed, it must be carefully watched as loads cross the bridge. If further deformation takes place, the member must be treated as if it were severed, and the effect on the strength of the bridge as a whole calculated accordingly. Repairs can then be carried out as shown in Sec. **37**.

Example.—It is assumed that a 90 ft. span, Class 30 double single bridge has been damaged as follows :—

Example 1.—In the third bay from the end, both channels of the top chord of one truss are completely severed. In the same bay, but on the opposite side of bridge, the flange of one channel in the bottom chord of one truss is missing.

Example 2.—In the second bay from the end, the flange of one diagonal R.S.J. is severed.

Example 3.—In the first or end bay, the centre vertical R.S.J. of one panel is completely severed.

The immediate decisions to be made are :—

(*a*) Must the bridge be closed altogether ?

(*b*) Can the bridge be left open to take vehicles of a lower load class while repairs are being effected ?

Example 1.—Values for each side must be assessed separately. Considering the more heavily damaged side first, the chord of one of the two trusses is severed ; therefore the available resistance of bending stresses is reduced by half, or 50 per cent.

From the appropriate table in Plate XXXIV the bending stress percentages in the third panel are :—

Dead load ...	18 per cent.
Live load ...	61 per cent.
Total	79 per cent.

Therefore, as this section should take 79 per cent. of permissible stress, and is now only able to take 50 per cent., the bridge must be de-rated :—

Total load ...	... = 79 per cent.
Capacity as damaged	... = 50 per cent.
Difference	... = 29 per cent.

De-rating :—The dead load will remain unaltered at 18 per cent. Therefore, live load must be reduced by 29 per cent., *i.e.*, live load will be 61 per cent.-29 per cent.=32 per cent.

Since the reduction in live load percentage is approximately proportionate to the de-rating of the load class :—

New load class $=30 \times \frac{32}{61} = 15{\cdot}7$ (*i.e.*, nearest Class 12).

On the opposite side of the bridge in the third bay the damage is less, hence it will not be the criterion for strength. But assessing its value :—

The residual strength of the damaged chord is 54 per cent. (*see* Plate XXXIII) and as there are two trusses, the residual strength value of the girder is, therefore, $\frac{100+54}{2} = 77$ per cent.

The required strength value is 79 per cent. Therefore if this was the only damage, the bridge could still be allowed to take Class 30 loads, provided that traffic is controlled and vehicles travel slowly.

Example 2.—Diagonal in second bay with flange severed. From the diagrams on Plate XXXIII a 3 ins. by $1\frac{1}{2}$ ins. R.S.J. minus one flange is 24 per cent. effective.

Therefore, as the bridge is double truss, the total shear capacity of the damaged girder will be $\frac{324}{4} = 81$ per cent.

From Plate XXXIVA, the shear in the second bay is 63 per cent. of the full load capacity, so that this damage has no effect on bridge class.

Example 3.—Mid-vertical in end bay severed.

Vertical R.S.Js. are single panel members, therefore with two trusses the effectiveness of the girder is reduced to 50 per cent. at this point.

Referring to Plate XXXIVA the shear taken by the panel is :—

Dead load	18 per cent
Live load	50 per cent.
Total load	68 per cent.

But the girder is only 50 per cent. effective.

The total load must, therefore, be reduced by 18 per cent. to 50 per cent.

The permissible live load (dead load remaining constant) is 50 per cent.—18 per cent.=32 per cent.

Therefore load class is reduced to $\frac{32}{50} \times 30 = 19{\cdot}2$. (Class 18.)

It will be seen that the most serious damage is that considered in Example 1. Each problem must however be considered separately as above, in order to determine the load class to which the bridge as a whole must be reduced whilst repairs are carried out. The bridge considered would be reduced to Class 12

Repairs as described in Sec. 37 below would then be carried out in order to restore it to Class 30.

SECTION 37.—METHOD OF REPAIR

1. The most satisfactory method of carrying out repairs *in situ* is by the addition of complete parts. Welding repairs can be done, but great care must be taken in the execution of the work, or serious damage can be caused. Repair by welding is not considered here, but details can be found in M.E., Vol. III, Part IV.

2. Most of the secondary components of a bridge, such as the complete decking system, rakers, sway braces, and bracing frames can easily be removed and replaced by new components. The removal of a panel, however, is virtually impossible without first delaunching the bridge. Serious damage to any panel part, involving reduction in load class of the bridge as a whole, will normally therefore be repaired locally by one of the following methods, which can be used singly or in combination :—

(*a*) Extra trusses, *e.g.*, double single bridge locally converted to triple single.

(*b*) Extra storey, *e.g.*, triple single bridge locally converted to triple double.

(*c*) Supplementary chords bolted to the top and bottom chords of the bridge.

Method (*a*) is only applicable to single or to double truss bridges, and method (*b*) to double and triple truss bridges ; this method will also normally be confined to triple single or triple double construction, because it is easier to add a truss than a " storey " to double truss bridges. Supplementary chords can be used on any type of bridge, but should be avoided as far as possible for triple storey bridges, since their use involves the removal of the top bracing. Generally, they will be used when sound chords are available from panels which have been cut up for salvage because of damage to verticals and diagonals.

3. When a bridge is strengthened by either one, or a combination of the above methods, the following points must be noted.

(*a*) Additional panels or chords must be extended alongside or over five bays ; that is the damaged bay itself, and the two bays on either side of it.

(*b*) If the damage occurs in the end bay, the reinforcement must extend for three bays, and if in the second bay it must extend for four bays.

Example.—Class 30 90-*ft. span double single bridge.*

Example 1.—Damage

(*a*) Both channels of top chord of one truss completely severed.

(*b*) One flange of bottom chord of one truss of opposite girder severed.

Assessment of damage as in Sec. **36**.

Repair

(*a*) Add third truss to first five bays of bridge.

(*b*) Add supplementary chords to first five bays on bottom chord only.

Although the damage in (*b*) does not have such a severe effect, a repair should nevertheless be carried out so that no restrictions need be placed on speed of traffic.

Example 2.—Damage caused to diagonal of the second bay requires no repair.

Example 3.—Mid vertical in end bay severed. Damage assessed as in Sec. **36** :—

(*a*) If the damage were on the same side as in 1 (*a*) the repair effected for that damage would cover this example also.

(*b*) If the damage were on the same side as 1 (*b*) this factor would decide that the repair should be additional panels and not supplementary chords, so that the same repair would cover both cases.

BAILEY PONTOON BRIDGE

CHAPTER 10

GENERAL DESCRIPTION OF THE EQUIPMENT

SECTION 38.—GENERAL DESIGN

1. The Bailey pontoon bridge is a straightforward development of the fixed span bridge. It consists of a series of short Bailey spans supported on floating pontoon piers, with approach spans from the banks at each end. The three main parts of the bridge are termed :—

(1) Floating bays.

(2) End floating bays.

(3) Landing bays.

Normally bridges will be formed of two landing bays, two end floating bays, and any number of floating bays as required to fill the remainder of the wet gap.

2. The superstructure and roadway of the floating bays are formed of exactly the same components as fixed span bridges, and may be of single single or double single construction according to the load class of the bridge. The bracing is the same as already described for these types of construction.

3. Pontoon piers each consist of two Mk. V or Mk. VI bow pontoons, coupled to a special centre section. These form a tripartite pier 60 ft. in length. The centre pontoon is slightly longer at the top than at the bottom, so that the pier has a slight camber before it is loaded.

Two or three tripartite pontoon piers are used for each floating bay. A special pier composed of four or six of these pontoon piers supports the inshore end of the end floating bay and the floating end of the landing bay. This is termed the landing bay pier. Special parts, namely, the distributing girder and landing bay transom, are used on this pier. These are described in Sec. **41.** The offshore end of the end floating bay is supported on a single pontoon pier.

4. The landing bays, or approach spans, are normal fixed spans resting on baseplates and bearings at the shore end and on the landing bay transom at the floating end. They may be of any form of construction up to triple double, according to the span and the load class required. Limitations of slope and maximum bank heights are discussed in Sec. **43,** para. 2. Access to and from the landing bays at the banks is by means of ramps, which are the same as those described for fixed bridges.

5. Connection between the different portions of the bridge is made by means of special posts which are attached to the superstructure of the bridge. These are connected together by a pin joint at the bottom only, so that a limited amount of articulation is possible. Three different types of post are used, for floating bay, end floating bay, and landing bay. The connecting posts used at each end of floating bays add an extra 2 ft. in length to the raft. The end floating bay has a connecting post at one end and a hook post at the other increasing the total length by 1 ft. 6 ins. The landing bay has a hook post at the offshore end only, increasing its length by 6 ins. All these increases are above the number of standard 10-ft. Bailey panel lengths.

6. Tidal and flood conditions introduce certain complications as the length of the bridge varies with the rise and fall of the tide. This question is discussed in Sec. **40**, and Table 4 shows the amount by which each landing bay will lengthen for a given rise of tide.

7. An alternative form of approach span is the half floating bay, which can be used for Class 40 bridges and below. This makes for a certain saving in equipment, and with the aid of the launching link Mk. II allows a useful range of bank heights. It will save time spent in ferrying stores, if used for the far banks. Details of construction and use of the half floating bay are given in Sec. **47.**

Section 39.—LOAD CARRYING CAPACITY

The pontoon bridge is normally built for two load classes only, Class 40 and Class 70, but lower and intermediate classes can be used as shown in the table below. Generally speaking, two pier rafts with single single superstructure are used for Class 40 loads, and three pier rafts with double single superstructure for Class 70 loads. The landing bay piers have four tripartite piers and six tripartite piers respectively for loads below and above Class 40. The limiting spans for the different types of construction used in the landing bay are the same as for fixed span bridges. Details of spans for different load classes are shown in Table 3 below.

It will be seen that the length of the floating bays and end floating bays are different for the same load class. The reason for this difference is that different types of connecting post are used on the two types of bay, and it should be carefully noted, because it is an important factor when the design of a bridge to suit a particular gap is considered.

With loads over Class 40, in addition to double single construction and extra piers, heavier landing bay transoms and distributing girders, as well as Class 70 decking system must be used. The approach ramps and end transoms at the shore end of the landing bays must be packed at the centre point where necessary in the same way as for fixed span bridges. (Chapter 8.)

The net buoyancy of a tripartite pontoon pier is 14·5 tons at 8 ins. freeboard (measured from gunwale), and the displacement is approximately 1·41 ins. per ton.

TABLE 3

Maximum spans and type of construction, floating bay, end floating bay and landing bay

Class	Floating bay		End floating bay		Landing bay		Notes
	Type	Max. span	Type	Max. span	Type	Max. span	
9	S/S	92 ft.	S/S	91ft. 6in.	S/S D/S T/S D/D	90 ft. 6 ins. 150 ft. 6 ins. 170 ft. 6 ins. 180 ft. 6 ins.	(1)
12	S/S	82 ft.	S/S	81 ft. 6 ins.	S/S D/S T/S D/D	80 ft. 6 ins. 140 ft. 6 ins. 160 ft. 6 ins. 180 ft. 6 ins.	(1)
18	S/S	62 ft.	S/S	61 ft. 6 ins.	S/S D/S T/S D/D	60 ft. 6 ins. 110 ft. 6 ins. 140 ft. 6 ins. 160 ft. 6 ins.	(1)
24	S/S	52 ft.	S/S	51 ft. 6 ins.	S/S D/S T/S D/D	60 ft. 6 ins. 110 ft. 6 ins. 140 ft. 6 ins. 150 ft. 6 ins.	(1)
30	S/S	42 ft.	S/S	41 ft. 6 ins.	S/S D/S T/S	50 ft. 6 ins. 100 ft. 6 ins. 120 ft. 6 ins.	(1)
40	S/S	42 ft.	S/S	41 ft. 6 ins.	S/S D/S T/S	40 ft. 6 ins. 80 ft. 6 ins. 110 ft. 6 ins.	(1)
40	D/S	52 ft.	D/S	51 ft. 6 ins.	D/D T/D	130 ft. 6 ins. 150 ft. 6 ins.	(2)
50	D/S	42 ft.	D/S	41 ft. 6 ins.	D/S T/S D/D T/D	60 ft. 6 ins. 90 ft. 6 ins. 110 ft. 6 ins. 130 ft. 6 ins.	(3)
60	D/S	42 ft.	D/S	41 ft. 6 ins.	D/S T/S D/D	50 ft. 6 ins. 80 ft. 6 ins. 100 ft. 6 ins.	(3)
70	D/S	32 ft.	D/S	31 ft. 6 ins.	T/S D/D	70 ft. 6 ins. 90 ft. 6 ins.	(3)

NOTES (1) Four pontoon piers in landing bay pier.
Class 40 decking system.
Two pier rafts.

(2) Six pontoon piers in landing bay pier.
Class 40 decking system.
Three pier floating bays.

(3) Six pontoon piers in landing bay pier.
Class 70 decking system.
Three pier rafts.

SECTION 40.—EFFECTS OF TIDE ON LENGTH OF BRIDGE

The amount of movement at the shore end of a landing bay due to rise or fall of tide is dependent upon the length of the landing bay. Table 4 shows the approximate movement in inches for different lengths of landing bay with tidal ranges from 4 ft. to 20 ft. Thus when the appropriate length of landing bay has been selected according to the methods described in Chapters 11 and 12, the movement for each bay can be found, and the sum of these give the total movement for any particular bridge.

TABLE 4

Alteration in length of landing bays for different tidal ranges

Length of Landing bay. Ft.	Tidal range in ft.								
	4 ft.	6 ft.	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.
50	2½ ins.	4½ ins.	7½ ins.	12 ins.	17½ ins.	24 ins.	31½ ins.	40 ins.	50 ins.
60	2 ins.	4 ins.	6½ ins.	10 ins.	14½ ins.	20 ins.	26 ins.	33 ins.	41 ins.
70	2 ins.	3 ins.	5½ ins.	9 ins.	12 ins.	17 ins.	22 ins.	28 ins.	35 ins.
80	1 in.	3 ins.	5 ins.	7½ ins.	11 ins.	15 ins.	19 ins.	25 ins.	31 ins.
90	1 in.	2½ ins.	4 ins.	6½ ins.	10 ins.	13 ins.	17 ins.	22 ins.	27 ins
100	1 in.	2 ins.	4 ins.	6 ins.	9 ins.	12 ins.	15½ ins.	20 ins.	24 ins.
110		2 ins.	3½ ins.	5½ ins.	8 ins.	11 ins.	14 ins.	18 ins.	22 ins.
120		2 ins.	3½ ins.	5 ins.	7 ins.	10 ins.	13 ins.	16 ins.	20 ins.
130		2 ins.	3 ins.	5 ins.	7 ins.	9 ins.	12 i s.	15 ins.	18 ins.

The total amount of movement which can be catered for by the baseplates alone is 18 ins. When the tide range is such that the movement of the baseplates is sufficient to deal with it, one bay of cut stringers, as illustrated at Plate XXIV, must be introduced to deal with the movement of the decking. An estimate of the state of the tide should be made when the bearings are positioned on the baseplate, so that movement in the appropriate direction will be possible.

When calculating the increase in length of the bridge, the maximum tidal range to be considered will be from low water to baseplate level, or from low water to high water whichever is the smaller, as the maximum elongation of the bridge will be when water level and baseplate level coincide.

In order to deal with long bridges and large tidal ranges, two types of sliding bays have been introduced for load classes up to and above Class 40. These are also useful for forming a cut in the bridge, particularly if the cut must be kept open for any length of time, during which the tide may rise or fall, and the length of the

bridge consequently alter. Details of the special parts required and the method of construction for each type of sliding bay, are contained in M.E. Vol. III, Part IV.

SECTION 41.—DESIGN AND PURPOSE OF EACH PART

1. Full descriptions of the parts used for the decks and superstructure of the bridge have already been given. Only the extra parts required for use with the floating bridge are described in this section.

2. **Centre pontoon** (Plate XXVII).—This is of similar construction to the Mk. V bow pontoon, but is rectangular in shape, and has steel frames stiffening the sides. It has the usual couplings on the decks and sides for connecting up with bow pontoons, thus forming the tripartite pier.

One bulkhead in the centre divides the pontoon into two compartments, and pumps are provided which are permanent fixtures for each half. Four hatches are provided, so that if the pumps are not accessible, pumping out can be done by means of suction hose.

Recessed convex steel bearing surfaces are provided on the gunwales to position the panels of the superstructure correctly. A position (without curved bearings) is also provided at each end of the gunwale to take the DISTRIBUTING GIRDERS used on the landing bay pier. Anchorages are provided to fasten the distributing girders to the pontoons by means of riband bolts. Only the centre pier of three pier rafts is anchored to the superstructure ; this is done by use of the PANEL ANCHORAGE BLOCK.

The centre pontoon weighs 1 ton and is a 24-man load. The use of the Coles crane and pontoon carrying bars is advisable when loading and offloading.

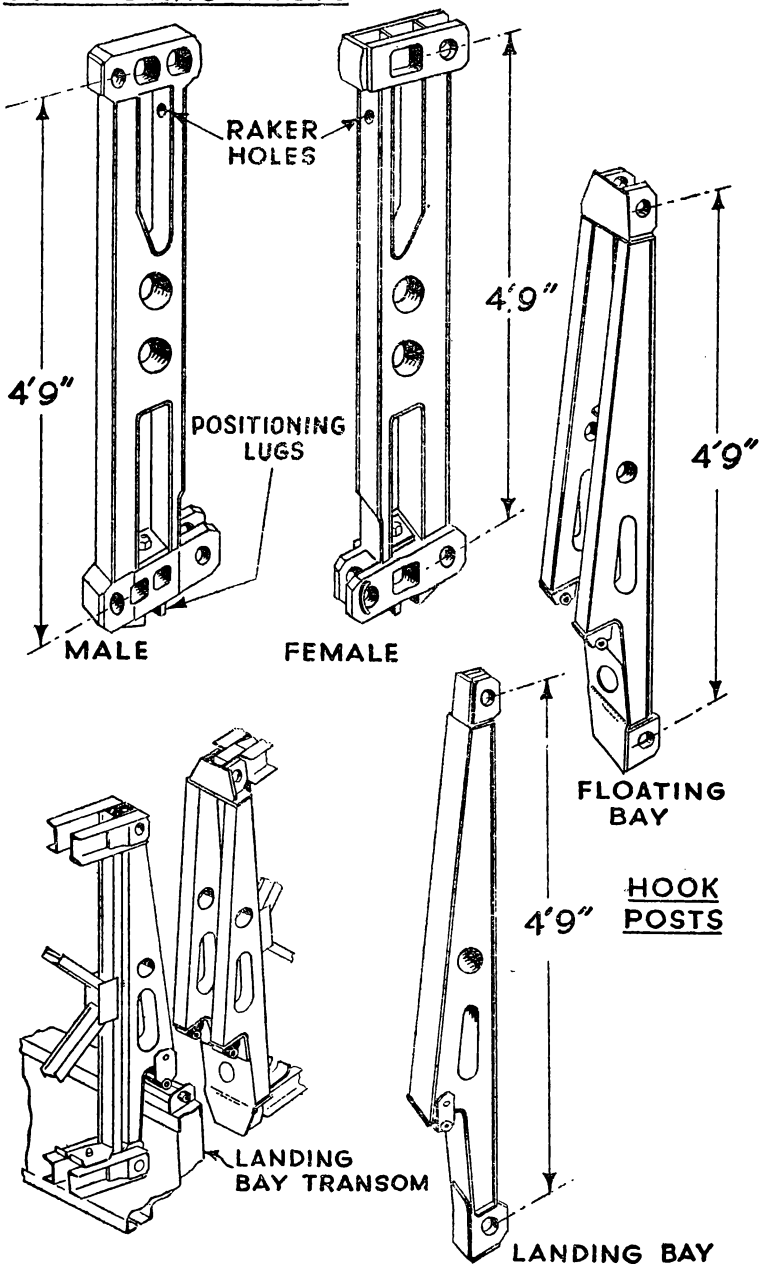
3. **Pontoon Mk. VI** (Plate XXVIII).—This is a bow pontoon of the same external form and dimensions as the pontoon Mk. V. It is, however, an open boat except for a short length of deck at bow and stern. Couplings are identical with those of the Mk. V and centre pontoons, so that any combinations of the three can be used. Four rowlocks are provided each side of the pontoon, and one steering rowlock at each end. Bollards, towing ring, drain plugs, and anchorages for the propulsion unit are the same as for the Mk. V pontoon. No pumps are provided, water being removed by suction hose or baling.

Side, bottom, and stern plywood panels remain unaltered, but the timber framework towards the stern is reinforced with a steel bracing system. The well is divided into two compartments by a low bulkhead, each compartment having a removable duckboard floor to protect the bottom.

The open well is provided with a collapsible canvas combing or dodger 9 ins. high. It is held in position at the top by lacing to a tube held by clips to the rowlocks, and at its base by sandwiching between the footrail and the deck. When not in use, it hangs down

PLATE XII

CONNECTING POSTS



inside the well. To save wear, it should not be put up until the bridge is ready for use.

As the deck is open, drain plugs should always be removed during transit and storage.

This pontoon cannot be used for the two pontoon pier type of Bailey Class 40 Raft, without the addition of bearing pads to the gunwales. If both Mk. V and Mk. VI pontoons are used in the same bridge, the Mk. Vs. should all be left together on the upstream side, which will facilitate the work of construction.

4. **Connecting posts.**—Floating bays are joined together by means of connecting posts, which are attached to the panels at each end of a normal floating bay. These posts are of two types, male and female, provided with male and female jaws respectively for use at the female and male ends of the panels. Each type has exactly similar jaws at the bottom, which are offset so that any two connecting posts, male or female, can be pin jointed together. A panel pin is used here, but as there is a considerable clearance in the pin holes, for ease of erection, it is essential that split pins are always inserted. At the top end is a bearing block which butts against the corresponding block on the opposite post ; the result is that at a junction between floating bays, free articulation in the hogging direction is possible, but in the sagging direction there is only a small amount of articulation, so that when a vehicle reaches this point on a bridge its weight is spread over several pontoon piers.

There are positions for a transom and raker on each connecting post. Lugs are provided under the bottom of each post, and these fit each side of the curved bearings on the pontoon, so that they position the bridge girders on the pontoons.

A connecting post, male, weighs 142 lb.

A connecting post, female, weighs 157 lb.

A guard is provided to cover the gap at the top of the connecting posts, to prevent fingers from being pinched in the gap between the bearing blocks. This consists of a light pressed channel, with two chains and hooks to hold it in place on the connecting posts.

5. **Hook posts.**—Connection between the landing bay and the end floating bay is made by hook posts, which are of two types, one for landing bay and one for floating bay. They are NOT interchangeable.

(*a*) *Landing bay hook post.*—This is used on the floating end of the landing bay, one on each panel. It is provided with male jaws at top and bottom, for connection with the female end of a panel. *No female type is provided, and therefore it is essential that the landing bays shall be built with the female panel jaws offshore.*

The front of the hook post is shaped in the form of a nose, with a hollow tubular bearing welded on to the horizontal portion. This rests on the bearing surface of the LANDING BAY TRANSOMS, and is held in position

by the transom pin. The tubular bearing is capable of a small amount of lateral movement relative to the rest of the hook post. This allows the landing bay to be slightly skewed in relation to the landing bay transom and the remainder of the bridge.

The weight of the landing bay hook post is 84 lb.

(*b*) *Floating bay hook post.*—This is used on each of the panels of the end floating bays nearest the shore. It is provided with female jaws top and bottom, to fit on to the male end of the panel. *No male type is provided, and therefore it is essential that the end floating bays shall be built with the female panel jaws offshore,* except in the class 70 end floating bay, when construction starts from the hook posts (Sec. **52**, para. 3).

The floating bay hook post is of welded construction similar to the landing bay hook post, but with a double nose. It has two bearings which rest on either side of the landing bay hook post. The transom pin passes through all these bearings.

The shapes of the two opposite hook posts permit of a considerable degree of articulation without fouling each other.

A floating bay hook post weighs 105 lb.

6. **Landing bay transom.**—There are two types of landing bay transom, one for Class 40 and one for Class 70 loads.

(*a*) *Class* 40 *transom.*—This is a welded lattice girder with shallow hornbeam-shaped ends. It is supported at each end on the distributing girders, while the belly of the transom hangs down between the centre pontoons of the landing bay pier.

Concave semi-cylindrical bearings are provided on top of the transom near each end to take the hook posts of the landing bay and end floating bay. The bearings are provided with ears to position the hook posts; these have holes in them so that the transom pin can pass right through to hold the hook posts down. The top of this transom is arranged to be at the same level as that of the normal bridge transoms, and is provided with similar stringer cleats to position the JUNCTION CHESSES. It is also arranged that the bridge girders of the landing bay on one side, and of the end floating bay on the other, are clear of the curved bearings on the landing bay pier.

A Class 40 landing bay transom weighs 790 lb. and is carried by 8 men.

The transom pin referred to above is provided with a tapered point, and a hole through the point for a standard split-pin, as used for panel pins. The transom pins should be retained, one at each end of the landing bay transom, by means of the split pin both in use and during transport. The transom pin weighs 10½ lb.

(*b*) *Class 70 transom.*—This transom fulfils exactly the same function as the Class 40 transom, and it is therefore provided with similar attachments. It is, however, stronger and heavier and consists of six parts, viz. :—

(i) Transom panel.

(ii) Two hornbeams.

(iii) Panel saddle.

(iv) Two hornbeam saddles.

These are described below.

(i) The transom panel is similar to the Bailey panel, and has similar attachments, but the depth between main chords is only 3 ft. In addition to the male and female lugs, there are two intermediate joints on the top chord to receive the male lugs of the transom saddle. Other fittings on the panel do not affect the pontoon bridge. The transom panel weighs 558 lb. and is carried by six men.

(ii) The hornbeams are of two types, B and C, one having male lugs and the other female lugs at the deep end. They are attached to the transom panel by means of panel pins. Special short pins are provided for the lower joint to assist in lowering the completed transom between the pontoon handrails. Normal pins can, however, be used in emergency, provided the piers are levered as far apart as the distributing girder stops will allow. The two outer holes of the top chord take the lugs of the hornbeam saddle; other fittings are not used in the pontoon bridge.

Each type hornbeam weighs 318 lb. and is carried by four men.

(iii) The panel saddle consists of a thin inverted steel trough. It has two lugs on the underside which are placed between the channels of the top chord of the transom panel, and are fixed by pins passing through the intermediate jaws. Cleats are provided on the upper side to position the deck stringers. The saddle weighs 106 lb. and is carried by two men.

(iv) Hornbeam saddles drop into the top chord of the hornbeams and are fastened by panel pins, the holes nearest to the end of the hornbeam being used for this purpose. On no account must pins be inserted in the holes nearest to the centre of the hornbeam, as these will foul the hook posts. The saddles carry fixed bearings for the hook posts similar to these on the Class 40 transom, and are

provided with a similar transom pin. The hornbeam saddles weigh 58 lb. each. The total weight of the assembled transom with ten panel pins is 1,596 lb.

7. Distributing girders

(*a*) *Class* 40.—These are triangular shaped panels, of welded construction like the bridge panels. Two girders couple together at their deep ends, by means of a panel pin through the jaws at the bottom, to form a hinged joint. The pins must be inserted from the inside, or they will interfere with the seating of the landing bay transom, fouling the hornbeam.

The top chords of each girder panel terminate in a bearing pad. Two pairs of distributing girders rest on the four pontoon piers of the landing bay pier, close to the outer ends of the centre pontoons, and outside the transoms of the bridge. There are four stops on the underside of each distributing girder, to position them on the pontoons. The bearing pads allow free articulation between distributing girders in the hogging direction only. Seatings are provided on the top of the bottom chord so that riband bolts can be used to anchor the distributing girders to the pontoons.

The landing bay transom rests on the jaws at the junction of the distributing girders. Both the landing bay and the end floating bay are carried on this transom, so that it transmits their end reactions to the distributing girders, and through them to the pontoons of the landing bay pier. A sliding pin in the end vertical member of each distributing girder is pushed across above the landing bay transom to act as a retainer.

A distributing girder weighs 520 lb. and is carried by six men.

(*b*) *Distributing girder centre section* (*Class* 70).—This is a gable-shaped welded panel which fits between the girders described above, thus forming a tripartite assembly, the whole of which constitutes a Class 70 distributing girder. It is pinned to the triangular sections at the bottom joint only.

A STIFFENING GIRDER ASSEMBLY is fastened to the top and bottom chords for additional strength, and as this is jointed together at the apex, no articulation of the distributing girder is possible. Before it is attached, however, the joints between the three portions are free, which simplifies erection.

The distributing girders are fixed to the pontoons by riband bolts as before. The landing bay transom is supported at the middle of the distributing girder centre section, and is held in position by a hinged strap plate.

The distributing girder centre section weighs 800 lb. and is carried by ten men.

8. **Stiffening girder assembly.**—This consists of two welded trusses, which fit on to the sloping side of the complete Class 70 distributing girder. They are provided with dowels on the inside edge, which drop into sockets on the top chord of the distributing girder, and are fixed by bracing bolts. Left and right handed trusses are provided to fit the opposite halves of the girder. They are joined at the apex by means of a bolt inserted through jaws, before they are fitted to the girder.

The assembly is completed by means of struts (one double, two long and two short). The upper ends of these are bolted to sockets under the outer edge of the truss ; the lower ends are fixed on brackets fitting over the riband bolt seatings on the bottom chords of the distributing girder, and are clamped in position by the same riband bolts which fix the distributing girder to the pontoon piers.

9. **Junction chesses** (Plate XIII).—To fill the gaps in the roadway, due to the fact that in a floating bay the connecting posts add 2 ft. to the normal multiples of 10 ft , special junction chesses are provided. These consist of timber fixed to short steel joists which are the counterpart of stringers. Three junction chesses rest across the two adjacent transoms fixed in the connecting posts. The junction chesses are provided with lugs on the under side which project below the flanges of the transoms to position the chesses longitudinally, while they are positioned laterally by the cleats on top of the transoms.

Junction chesses must always be used with the Class 40 landing bay transom, but NOT with the Class 70 landing bay transom

A junction chess weighs 62 lb.

10. **Panel anchorage block** (Plate XIV).—This is a small steel distance block provided with a slot through which a riband bolt can be inserted. Its purpose is to anchor the centre pontoons of a three pier raft to the bridge panels by means of a riband bolt.

A block is placed on the top of the lower chord in the crutch formed by the diagonals. The riband bolt is then passed through the block, and engaged with a socket provided on the centre pontoons. Four blocks are required per pontoon (double truss construction for Class 70).

Each block weighs 2 lb.

CHAPTER 11

CLASS 40 FLOATING BRIDGE

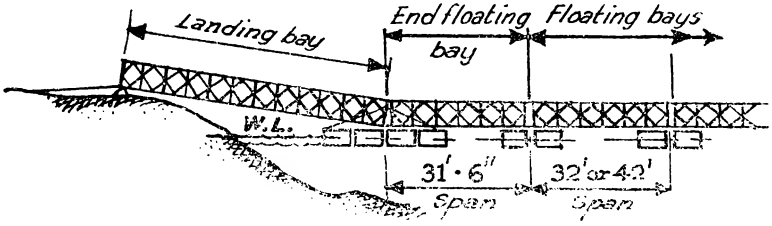


FIG. 8

SECTION 42.—GENERAL DESCRIPTION OF BUILDING A BAILEY PONTOON BRIDGE

First, make a thorough reconnaissance of the site, as described in Sec. **43**, and select suitable building sites for the different portions of the bridge. Ideally there will be four sites in all: two for the landing bays on the centre line of bridge, one on each bank; and two for the floating portions, preferably upstream of the centre line on the home bank.

Approaches both to the bridge itself and also to the building sites, must be carefully considered from the point of view of time and material; remember that up to 20 or more vehicles may have to be brought to each construction site.

Work is started on baseplate and roller grillages on each bank at the earliest opportunity, the stores for the far bank being ferried over on a pontoon pier. Construction of floating and end floating bays begins as soon as possible, and of the landing bays as soon as the roller positions are prepared. Stores for the construction of the far landing bay should be ferried over by the first available floating bay.

To form bridge, the two end floating bays are floated down to the centre line of the bridge, so that both landing bays can be launched and connected with the landing bay transoms. The home landing bay is then boomed out and jacked down on to its bearings so that the end of the bridge is fixed. Enough floating bays are then connected with each end floating bay to fill the remainder of the gap. Finally, the far side landing bay is boomed out, so that connection is made between the centre floating bays. Bearings and baseplates on the far bank are then adjusted to take up any small inaccuracy in the original setting out, and the shore end of the landing bay is jacked down. Ramps are positioned at each end of the bridge.

The floating portion of the bridge is anchored with the normal pontoon anchors and cables. Upstream and downstream anchors should be provided as is usual for floating bridges.

SECTION 43.—SITE RECONNAISSANCE, DESIGN CONSIDERATIONS, AND BRIDGE DESIGN

1. **Site reconnaissance.**—The information required about the gap is as follows:—

(*a*) Width of water gap.

(*b*) Distance from each bank that water is 9 ins. deep.

(*c*) Distance from each bank that water is 24 ins. deep.

(*d*) Check that there are 24 ins. of water over the whole gap between distances found at (*c*), and that this depth of water is available for 30 ft. on each side of the centre line.

(*e*) Height of each bank above water level.

(*f*) Profile of each bank, and of centre line for a distance equal to the length of landing bay from edge of gap.

(*g*) Select building sites, preferably upstream, for floating bays and end floating bays.

(*h*) Work required on approaches:

(i) To bridge.

(ii) To building sites.

2. **Design considerations**

(*a*) *Limitations of bank heights, and slope of landing bay.*—The maximum allowable slope of the landing bay when loaded is 1 in 10. The deck height on the bank is 2 ft. 4 ins. above baseplate, and the deck level at the landing bay transom when loaded is 2 ft. 4 ins. above water level; therefore the landing bay will need to be 10 ft. long for every foot the underside of the baseplate is above low water level. The maximum height of decking above water level with the four pier landing bay pier will therefore be 13 ft. 4 ins.; this can be increased to 17 ft. 4 ins. if the Class 70 landing bay pier is used (*see* Table 3).

When launching the landing bay, the maximum slope possible, with hook posts in position, is 1 in 6·5, which is the slope at which the bearing pads on the two hook posts (landing bay and end floating bay) will make contact. This slope can, however, be increased by not positioning the hook posts of the end floating bay until after the landing bay has been launched and boomed out some distance.

(*b*) *Level of baseplate and ramps.*

(i) The ruling factor determining the depth to which the baseplates, at the shore end of the landing bays, should be sunk, is the slope of the approach ramps. The ramp should, wherever possible, be 10 ft. long only, and should be level. The required depth to which the baseplate must be sunk is given in Appendix E. This will reduce the height of the

bank, which will affect the design of landing bays in (*a*) above. If a 20-ft. ramp is provided, great care must be exercised in giving adequate support for the intermediate transom when tidal conditions are encountered ; this transom is very liable to overturn, because of the changes in length of bridge.

(ii) The baseplate can be sunk to a depth of 2 ft. below high water level, provided that adequate bearing is provided, and precautions are taken against scour. This arrangement increases the tidal range of the landing bay as explained in Sec. **40**. If, however, the double storey landing bays are to be used in conjunction with the Class 70 landing bay pier (Table 3) the baseplate must not be positioned at a less height than shown in Table 5 below. Introduction of packing between the landing bay transom and distributing girder enables this minimum height to be reduced in accordance with Table 5. Details of the type of packing to be used are given in Sec. **51**.

TABLE 5

Minimum Bankseat Height Class 40 Bridge, with Class 70 Landing Bay Pier

Load class	Type of landing bay	Bankseat height		
		Minimum height	Permissible reduction in inches per inch of packing	Maximum amount of packing
40	130 D.D.	2 ft. 9 ins.	8 ins.	5 ins.
	150 T.D.	2 ft. 3 ins.	9 ins.	4 ins.

(*c*) *Depth of water required.*—The minimum depth of water under the inshore pier when loaded is 24 ins. This will determine the minimum length of landing bay for design purposes. The distance from the landing bay transom to the inshore edge of the inshore pier can be taken as 14 ft. 0 ins.

For launching a landing bay, 9 ins. of water are required under the inshore pontoons of the landing bay pier. This depth will determine how close the landing bay transom can be brought to the launching rollers. Allow 14 ft. 0 ins. from the transom to the edge of the inshore pier, as before ; this distance can, however, be reduced to 7 ft. 0 ins. for launching purposes if the inshore pontoons are removed and floated back into position after the landing bay has been boomed out some distance. If the distance from the landing bay transom to the rollers is greater than half

the length of the landing bay a false tail or counterweight, or both, will have to be added.

(*d*) *Roller layout and levels for landing bay.*—The layout of rollers for the construction and launching of the landing bay is the same as described for fixed span bridges, except that the launching roller should be placed 5 ft. in front of the baseplate, in order to allow for final adjustments in the length of the bridge.

The relative levels of the rear construction roller, and the launching rollers, are adjusted as follows: The construction roller is fixed at a convenient height in accordance with the ground levels of the site; the rocking roller can then be fixed at a height so that the line of sight through the tops of the rollers will pass at least 6 ins. above the landing bay transom in the position it will occupy during the launch. The landing bay transom will be 3 ft. 0 ins. above water level in its unloaded position. This height gives a wide range for the selection of the launching plane, and clearly the most convenient will be slightly downhill.

3. Example of bridge design

(*a*) The three main considerations in design are as follows:—

(i) To fill the maximum water gap with minimum equipment.

(ii) To have the home bank landing bay as long as possible.

(iii) To have the far bank landing bay as short as possible, consistent with the rules for slope of bay and depth of water under pontoons, in order to reduce the quantity of stores to be ferried over.

(*b*) The variable components are as follows:—

(i) Landing bays, calculated as shown above.

(ii) End floating bays—These are normally taken as 31 ft. 6 ins. long, but may be 41 ft. 6 ins. There are always two of these, so that an allowance of 63 ft. can be made for both of them.

(iii) Floating bays can be 22, 32, or 42 ft. long; a combination of these lengths is arranged to fill the remainder of the wet gap.

The baseplates can then always be moved to take up an odd foot in length.

(*c*) *Example.*—240-*ft. water gap of section as in Fig.* 9

(i) *Far landing bay.*—Minimum length of far landing bay=50 ft. (slope 1 in 10). Actual length with connecting post is 50 ft. 6 ins.

Minimum distance from water edge for baseplate=5 ft. 0 ins. (angle of repose).

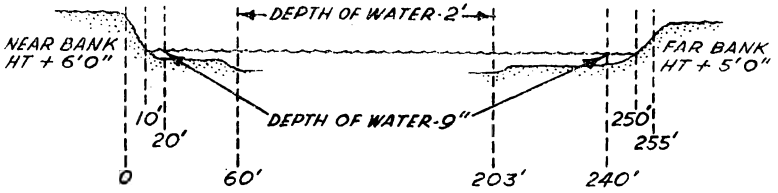


FIG. 9

Landing bay transom will be 45 ft. 6 ins. from water edge. Therefore the inshore edge of inshore pier will be 31 ft. 0 ins. from water edge ; but there is insufficient water (24 ins.) to float the bridge until 47 ft. 0 ins. from water edge.

Far landing bay must therefore be 70 ft. 0 ins. long, and landing bay transom will be 65 ft. 6 ins. from water edge. Construction will be double single.

(ii) *Near landing bay.*—Most convenient form of construction will be 110 ft. 6 ins. triple single. Therefore with baseplates at zero mark (10 ft. from water edge), the landing bay transom will be 100 ft. 6 ins. from water edge, and the depth of water under the inshore pier will be sufficient. Slope of bay is well within the limit.

(iii) Remaining water gap to be filled is 240 ft.—100 ft. 6 ins.—65 ft. 6 ins.=74 ft.

Make one end floating bay 41 ft. 6 ins. and the other 31 ft. 6 ins.

Length of floating equipment will be 73 ft.

If the baseplate on the home bank is moved forward 1 ft., this will be satisfactory. Sketch below shows completed design.

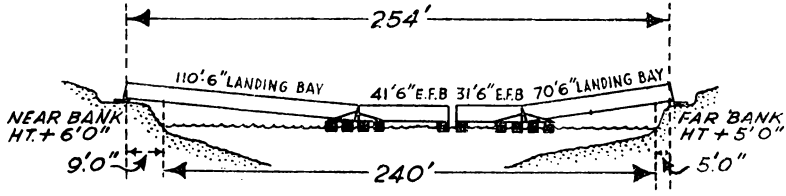


FIG. 10

SECTION 44.—CONSTRUCTION AND LAUNCHING OF LANDING BAYS

Construction of the landing bay is the same as already laid down for fixed span single storey bridges, with the following exceptions :—

(*a*) No launching nose is required.

(*b*) Front bays of landing bay are undecked to assist balance.

(*c*) Transoms are positioned BEHIND verticals. Except when used with Class 70 landing bay transom.

(*d*) In view of (*c*) bracing cannot be tightened in any bay until the transoms of the next bay have been fixed.

It is emphasized that female jaws of panels *must* be forward for this type of construction, since only male type landing bay hook posts are provided; also that a transom must be positioned immediately behind the hook post, so that the landing bay transom will not be excessively loaded.

The launching rollers should be as far forward as possible, and all rollers positioned and levelled in accordance with the rules already given. Normally, it will be possible to push forward to the point of balance, and manœuvre the landing bay pier inshore sufficiently to enable the head of the landing bay to reach the landing bay transom while balanced. The tail can then be raised, thus lowering the head until the hook posts rest on the landing bay transom. This operation requires great care, and in order to maintain control:

(*a*) a preventer tackle and anchorage must be provided at the tail of the landing bay; and

(*b*) a party must be on the landing bay pier to guide the end of the landing bay down.

It will be noted that there is only about 2 ins. clearance each side between the transoms of the landing bay and the distributing girders. The party on the pier is able to manœuvre it in the water relative to the landing bay with ease, but an officer or senior N.C.O. should personally direct this operation.

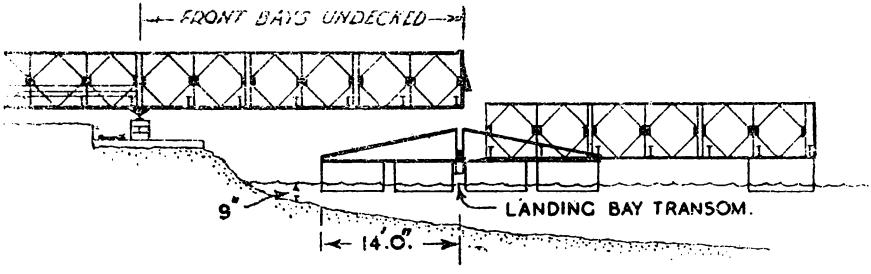


FIG. 11

As soon as the bearings of the hook posts are resting in their seatings on the landing bay transom, the transom pin is pushed right through the bearings, from the outside; the retaining pins on the distributing girders should then be pushed home above the ends of the landing bay transom, and split pins inserted in the transom pins.

The whole landing bay and pier can now be boomed out from the bank as far as is necessary.

SECTION 45.—CONSTRUCTION DRILL—FLOATING BAY

Connect up four bow and two centre pontoons to form tow tripartite piers, checking carefully that the couplings are fully

engaged and the safety catch locked home. Warp the two piers into position parallel with the shore. A third pier inshore of the other two piers is a great help, if sufficient stores are available. If a strong current is running up and downstream anchors should be cast 40 ft. offshore, otherwise breastlines will be sufficient.

Lay chesses as ramps between the shore and the inshore pier in the centre and at one end. Carry on ten transoms, and position them on the bow sections of the piers as follows :—

	Upstream	Downstream
Offshore pier...	2	2
Inshore pier	3	3

these are all positioned upstream on the Mk. V pontoons if both Mk. V and Mk. VI are in use.

Bring up two panels with the female jaws offshore, and attach the male connecting posts ; pass the first transom through in front of the centre verticals of the panels, and clamp down ; then pass the second transom through the connecting posts and attach rakers.

Lift the whole structure until the lugs on the underside of the connecting post engage with the inner curved bearings on the offshore gunwale of the offshore pier.

Pass a third transom through in front of the rear verticals, and attach rakers and sway braces ; tighten sway braces and clamp down the transom. At the same time two further panels are added to the originals.

Position the fourth transom in front of the rear verticals of the second panels, and attach rakers and sway brace. Boom out the offshore pier until further panels can be connected. Pass the centre transom through the second bay, tighten sway braces and clamp down. This process is then repeated for the required number of panels.

Finally, position the female connecting post on the inshore end of the last panel, pass a transom through and attach rakers. Boom out the required distance, lifting the inshore end of the panels so that the positioning lugs on the underside of the post are astride the curved bearings on the inshore gunwale.

Check up on tightness of all bracing, and deck down, placing three junction chesses at the inshore end between the last transom in the inshore panel and that in the connecting posts. Three further junction chesses will be required at the junction of each floating bay. Place the usual anchors, etc. aboard before floating into bridge.

Section 46.—CONSTRUCTION DRILL—END FLOATING BAY AND LANDING BAY PIER

Three tripartite piers are formed as in Sec. **45**. These are brought up alongside each other, paralle to the shore. Anchors are then cast from the offshore pier 40 ft out in the stream or breast lines are used as in Sec. **45**.

Construction of the end floating bay is then begun, for which the two offshore piers are used. This is done in exactly the same way as described for the floating bay, except that the last panels are boomed out until the ends are 12 ins. inside the inshore gunwale of the third pier. Decking and hook posts are not added until a later stage.

Two distributing girder sections are now carried up and connected with the two inshore piers by riband bolts, using the outer seatings on each side of the centre pontoon sections.

Two further piers are now brought inshore of the existing ones. The landing bay transom is carried on board, and laid on one of the bow sections of the outer of these two piers. The remaining sections of distributing girders are now brought on board, and fixed to these pontoons.

The two complete distributing girders are then formed by joining the sections at their centres by panel pins, inserted from the inside, and secured by split pins. This action joins the four piers to comprise the landing bay pier.

The landing bay transom is then inserted between the distributing girders by mounting it on carrying bars which are laid on the gunwales of the two inner of the four piers. It is then rolled between the distributing girders to its final position, lowered on to its seating, and the retaining pins pushed home.

The end floating bay hook posts should now be connected to the panels by pinning at the top only. The bottom of the posts are then pulled away from the end verticals of the panels until the bearing rests in the groove on the top of the landing bay transoms. By means of hand spikes and man power the end floating bay (still undecked at this stage) can be lifted upwards and shorewards, pivoting on the bearing of the transom, until such time as the bottom pin can be inserted. The end floating bay may then be decked down.

Fixing the hook posts may be postponed, if necessary, until the landing bay is launched and the landing bay hook posts rest on the landing bay transom, thus avoiding possible fouling of the hook posts when launching from high banks. In this instance care must be taken to see that the landing bay hook posts are placed in the central position of the appropriate transom bearing.

A transom must always be placed in the end floating bay in the position adjacent to the landing bay transom. The deck is completed by means of junction chesses from this transom to the landing bay transom.

Section 47.—HALF FLOATING BAY

1. The half floating bay can be used as approach spans for floating bridge up to Class 40, replacing the landing bay. Even with the Class 40 arrangement some saving of panels is achieved, and in addition, it has the advantage that no landing bay transom or distributing girders are required. It is particularly suitable for use on the far bank, where the stores have to be ferried across the river.

2. The lengths of half floating bay shown in Table 6 below have been adjusted for the various load classes so that the bankseat heights given without the launching nose link, Mk. II, allow for a safe minimum freeboard on the pontoons. If the launching nose link, Mk. II, is inserted in the bottom chord of the superstructure at any panel joint, both upper and lower limits of the bankseat height will be raised by an amount equal to number of bays between link and bank times 13½ ins. A suitable range of bankseat heights can be obtained by standardizing the position of the launching link, Mk. II, at two bays from the offshore end of the half floating bay. Details of the heights obtained using the link in this position are given at Table 6, together with details of construction for the different load classes.

TABLE 6

Half floating bay—Construction and Bankseat heights

Load Class	Length of half-floating bay	Construction of bay.	Range of bank-seat height	Range of bank-seat height with link 20 ft. from head of bay
9	31	Single-single	0–2 ft. 2 ins.	1 ft. 1½ ins.– 3 ft. 3½ ins.
	41		0–2 ft. 6 ins.	2 ft. 3 ins. – 4 ft. 9 ins.
	51		0–2 ft. 10 ins.	3 ft. 4½ ins.– 6 ft. 2½ ins.
	61		0–3 ft. 2 ins.	4 ft. 6 ins. – 7 ft. 8 ins.
	71		0–3 ft. 6 ins.	5 ft. 7½ ins.– 9 ft. 1½ ins.
	81		0–4 ft. 0 ins.	6 ft. 9 ins. – 10 ft. 9 ins.
12	31	Single-single	0–2 ft. 2 ins.	1 ft. 1½ ins.– 3 ft. 3½ ins.
	41		0–2 ft. 6 ins.	2 ft. 3 ins. – 4 ft. 9 ins.
	51		0–2 ft. 8 ins.	3 ft. 4½ ins.– 6 ft. 0½ in.
	61		0–3 ft. 2 ins.	4 ft. 6 ins. – 7 ft. 8 ins.
	71		0–3 ft. 2 ins.	5 ft. 7½ ins.– 8 ft. 9½ ins.
	81		0–3 ft. 8 ins.	6 ft. 9 ins. –10 ft. 5 ins.
18	31	Single single	0–2 ft. 2 ins.	1 ft. 1½ ins.– 3 ft. 3½ ins.
	41		0–2 ft. 5 ins.	2 ft. 3 ins. – 4 ft. 8 ins.
	51		0–2 ft. 7 ins.	3 ft. 4½ ihs.– 5 ft. 11½ ins.
	61		1–2 ft. 10 ins.	4 ft. 6 ins. – 7 ft. 4 ins.
24	31	Single-single	1 in. –2 ft. 2 ins.	1 ft. 2½ ins.– 3 ft. 3½ ins.
	41		2 ins.–2 ft. 0 ins.	2 ft. 5 ins. – 4 ft. 5 ins.
	51		4 ins.–1 ft. 11 ins.	3 ft. 8½ ins.– 5 ft. 3½ ins.
	61		5 ins.–1 ft. 10 ins.	4 ft. 11 ins.– 6 ft. 4 ins.
30	31	Single-single	3 ins.–1 ft. 7 ins.	1 ft. 4½ ins.– 2 ft. 8½ ins.
	41		3 ins.–1 ft. 4 ins.	2 ft. 6 ins. – 3 ft. 7 ins.
40	51	Double-single	0–2 ft. 9 ins.	3 ft. 4½ ins.– 6 ft. 1½ ins.
	61		0–2 ft. 11 ins.	4 ft. 6 ins. – 7 ft. 5 ins.
	71		0–3 ft. 1 in.	5 ft. 7½ ins.– 8 ft. 8½ ins.
	81		0–3 ft. 3 ins.	6 ft. 9 ins. –10 ft. 0 ins.

The figures quoted in the above table will only be valid if the following conditions are observed in constructing the bridge.

(*a*) For Class 9 and 12 loads the first floating bay must be single-single, 92 ft. and 82 ft. span respectively.

For loads up to and including Class 30, the first floating bay must be single-single, 42 ft. span.

Remaining bays in each case are normal span for the appropriate load class.

(*b*) With Class 40 loads, where the gap is of sufficient width to include two or more floating bays, the first one adjacent to the half floating bay must be 32 ft. double-single construction with three piers, and the next 32 ft. double-single construction, but only two piers. For smaller gaps, however, the half floating bay may be connected directly up to a double-single 31 ft. 6 ins. end floating bay, supporting the landing bay from the far bank, or have only the first of the double-single floating bays inserted between the end floating bay and the half floating bay.

(*c*) One pier only is required to support the half floating bay for Class 18, 24, and 30 ; for Class 40 loads, two piers are required at 10 ft. centres.

(*d*) The maximum tidal range for which this type of construction is suitable is 2 ft.–3 ft. When such a tidal range is encountered allowance must be made for it as follows :— At high water the bankseat height above high water level must not be less than the permissible lower limit ; whilst at low water it must not exceed the upper limit.

3. The use of the launching link introduces two minor difficulties.

(*a*) The slope of the half floating bay will be approximately 1 in 9, at which slope there may be a tendency for wheel slip when the decking is wet.

(*b*) The decking at the junction of the bays where the launching link is fitted, should be arranged as shown in Plate XXV.

4. To construct the half floating bay, rollers are placed as near the edge of the bank as the angle of repose of the ground will allow. These can be plain rollers, and should be 5 ft. in front of the base-plate position.

A single tripartite pier is placed alongside and parallel to the bank, and the first bay of superstructure is erected as for a floating bay. The second bay of superstructure is then added, which will rest on the rollers. Subsequent bays are built as for a fixed span bridge, and are boomed out as every two or three bays are added behind the rollers. Transoms are fixed in front of uprights.

Finally, end posts are fitted and the shore end is jacked down on to bearings, the piers being carefully anchored by breastlines from the shore. The second pier, with Class 40 loads, is floated into position before the bay is jacked down. An alternative method of construction is to convert the 32 or 42-ft. floating bay on which the stores are ferried across the river into the leading bays of the half floating bay.

SECTION 48.—DRILL FOR FORMING CUT WITH BAILEY PONTOON BRIDGE

1. The party required for this drill is two sections, organized as follows :—

No. 1. Sec. N.C.O. I.C. raft.
N.C.O. I.C. and 2 handspike teams of 2 men each.
2 men on upstream anchor cables.
2 offshore pin men.
2 spare men.

No. 2. Sec. N.C.O. I.C. and 2 handspike teams of 2 men each.
2 men on downstream anchor cables.
2 inshore pin men.
3 spare men.

2. All action will be controlled by N.C.O. I.C. raft ; the sequence of actions being as follows :—

(*a*) Pin men remove pins from each end of the raft to be cut.

(*b*) (i) Two handspike teams will lever the jaws of the connecting posts of the raft that is to be cut at one end, so that they pass *above* those of the opposite connecting posts.

(ii) Two handspike teams will carry out similar actions at the opposite end, but will lever so that the jaws of the connecting posts on the cut raft pass *below* the jaws opposite. Levering at all four corners of the raft must be simultaneous, and the raft is passed downstream.

(iii) Spare numbers act as a counterweight to help in the above operation.

(iv) Anchor cable men let out and take in, respectively, on their up and down stream anchor cables.

(v) N.C.Os. I.C. handspike parties watch the connecting post jaws closely, and give immediate warning of any difficulty or jamming.

(*c*) The cut raft is floated down until the jaws on the upstream connecting posts meet those on the downstream connecting posts of the rafts on either side of the cut. The procedure detailed in sub-para. (*b*) above is then repeated. It is important that opposing jaws should be in contact *on both sides of the* cut raft before levering begins, otherwise one pair of jaws may be cleared and passed, but not the other, which will cause delay.

(*d*) The raft is passed downstream and warped in beside the bridge to one side or other of the cut. Spare numbers should be used to help the anchor cable men, and as breastline numbers, during the warning.

SECTION 49.—WORKING PARTIES AND TIMES

Working parties for Bailey pontoon bridges will be divided amongst the four construction sites ; one each for the two landing bays, one for the end floating bays, and one for the floating bays. Work should proceed on construction of each of these parts of the bridge simultaneously, where sufficient numbers are available. The parties required on each site are as follows :—

1. **End floating bays and floating bays.**—Parties required for the construction of each of these bays are identical ; they consist of 1 N.C.O. and 32 men, or 3 sections, employed on the following tasks :—

Two panel parties	12 men.
One transom party	6 men.
Panel pins	2 men.
Rakers	2 men.
Sway brace	4 men.
Transom clamps	2 men.
Breastlines	4 men.

The method of detailing parties should be by the section task system. This works out as follows :—

Section	Task	Detail
1	L.H. girder	Panels 6, Pin 1, Raker 1, Transom clamp 1.
2	R.H. girder	As 1 Sec.
3	Centre of bridge	Transom 6, Swaybrace 4.

Breastline men are spares from the sections, as available, the ideal being to have four, two holding in on breastlines, and two preventing the pontoons from grounding. All parties assist in decking and provision of anchors after construction is complete.

2. **Landing bays.**—Parties for the landing bays at each end of bridge are organized in exactly the same manner as described for fixed span bridges of the particular type of construction.

An advance party will be required for each of the construction sites ; also parties for work on the approaches.

3. The following times for the construction of the floating portions of the bridge are based on the assumption that the above parties are available, and pontoons are ready in the water. They do not include offloading stores.

42-ft. floating bay : 40 minutes by day, 60 minutes by night.

End floating bay : 55 minutes by day, 80 minutes by night.

Unloading pontoon lorries, and floating the pontoons will take 15 minutes per lorry by day and 25 minutes by night, using a party of 2 sections.

CHAPTER 12
CLASS 70 FLOATING BRIDGES

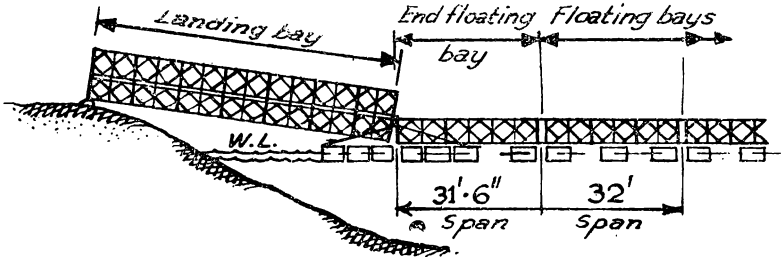


FIG. 12

SECTION 50.—GENERAL

The method of building a Class 70 floating bridge follows the same general lines as laid down for Class 40 bridges in Sec. **42**. The special parts required, their use, and the type of construction used, have all been mentioned. Reconnaissance and choice of building sites remain as described for Class 40 bridges. There are, however, certain differences in the design of any particular bridge, and in the method to be adopted in construction.

These are described in the ensuing sections.

SECTION 51.—DESIGN CONSIDERATIONS

1. **Limitations of bank height and slope of landing bay.**—The slope of landing bay for this class should not exceed 1 in 20, so that the height gained will be 6 ins. for each 10 ft. length of the landing bay. The maximum height of baseplate above low water level will therefore be 4 ft. 6 ins., using a 90 ft. 6 ins. double double landing bay. The maximum slope for launching remains at 1 in 6·5 but as the end floating bay hook post has to be in position on the landing bay transoms before the landing bay is launched, this cannot be exceeded.

2. **Level of baseplate.**—If a single bay of ramps is used, it must be level. If two or more bays are used, the bay nearest the bridge must be level, and the remainder at a maximum slope of 1 in 20. Baseplate levels in each method will be in accordance with Appendix E.

As there is no articulation in the Class 70 distributing girder, the height of the baseplate must be kept above the minimum levels given in Table 7, or the inshore pontoons of the landing bay pier will strike the underside of the landing bay, when loads cross the junction between the end floating bay and the first floating bay.

Clearly if packing is inserted between the landing bay transom and its seating on the distributing girder, this will increase the clearance between the landing bay and the pontoon piers, so that the minimum baseplates heights can be reduced. The allowable reduction in level per inch of packing inserted is also given in Table 7.

The maximum amount of packing that can be inserted varies according to the load class of the bridge and the length of landing bay; the figures are given in Table 7. No difficulty should be experienced in joining the end floating bay and the first floating bay when the packing is in position, providing the landing bay has been launched on to the landing bay pier. If any difficulty is then experienced, this can be overcome by driving transport on to the landing bay on the near bank, and by flooding the pontoons on the far bank, in order to further depress the landing bay pier; the far bank landing bay being still on rollers at this stage.

The maximum size of block that can be fitted between the landing bay transom and its seating will be 6 ins. long by 5½ ins. wide. The maximum load it must withstand will be approximately 45 tons, therefore the material used for the blocks must have a safe compressive stress not less than 1·4 tons per sq. inch. Ordinary Grade I timber will not be sufficiently strong.

TABLE 7

Minimum height of baseplate Class 70 B.P.B.

Load class	Type of landing bay	Bankseat height		
		Minimum height	Permissible reduction in inches per inch of packing	Maximum amount of packing
50	60 D.S.	2 ft. 6 ins.	3 ins.	4 ins.
	90 T.S.	2 ft. 9 ins.	5 ins.	5 ins.
	110 D.D.	2 ft. 9 ins.	6½ ins.	6 ins.
	130 T.D.	3 ft. 3 ins.	8 ins.	6 ins.
60	50 D.S.	2 ft. 6 ins.	2½ ins.	4 ins.
	80 T.S.	2 ft. 9 ins.	4½ ins.	5 ins.
	100 D.D.	2 ft. 9 ins.	6 ins.	6 ins.
70	40 D.S.	2 ft. 3 ins.	2 ins.	4 ins.
	70 T.S.	2 ft. 9 ins.	4 ins.	5 ins.
	90 D.D.	2 ft. 9 ins.	5 ins.	6 ins.

Measured from high water level to underside of baseplate.

3. **Launching landing bay.**—How near to the bank it will be possible to bring the landing bay transom will again depend on the distance at which 9 ins. of water will be available under the inshore pontoon of the landing bay pier. The transom in this case should be taken as 21 ft. 0 in. from the inshore edge of the pier. If the inshore pontoon is removed, this distance is reduced to 14 ft. 0 in.

4. Roller layout and levels will be the same as described for Class 40 bridges. The design of any particular bridge will follow the same general lines as previously described with the exceptions given in paras. 1, 2, and 3 above.

SECTION 52.—METHOD OF CONSTRUCTION

1. **Landing bay.**—The landing bay is built and launched as described in Sec. **44** for Class 40 landing bays.

2. **Floating bays.**—The floating bays are of double single construction with three tripartite piers, and 32 ft. in length. Decking is of Class 70 construction. Construction drill :—

(*a*) Warp three tripartite piers into position parallel with the shore. Make fast the offshore pier either by breastlines, or by anchors in a strong current. Carry on 14 transoms and place them on the bow sections of the pier as follows :—

No. 1 pier (offshore) ...	2 upstream, 2 downstream.
No. 2 pier	2 upstream, 2 downstream.
No. 3 pier	3 upstream, 3 downstream.

(*b*) Place two panels on the bearings on each side of the offshore pier, female jaws offshore. Position connecting posts on the female jaws of each panel. Place a transom through connecting posts from pier 1 and connect rakers loosely. Place transom through in front of rear verticals from pier 2, connect clamps and rakers loosely.

(*c*) Lift the whole assembly and position so that the lugs under the connecting posts are astride the offshore gunwale. Fit sway brace and bracing frames loosely, and position transom from No. 1 pier behind the front verticals, clamped loosely.

(*d*) Fix four more panels to the originals, sitting correctly on the gunwale seatings. Position transom from No. 2 pier behind front verticals and from No. 3 pier in front of rear verticals. Clamp loosely, and fix rakers to last transom.

(*e*) Boom out until centre vertical of second bay is over centre of No. 2 pier. Fit sway brace and bracing frames loosely to second bay. Make fast No. 2 pier to inner trusses, using four panel anchorage blocks and riband bolts.

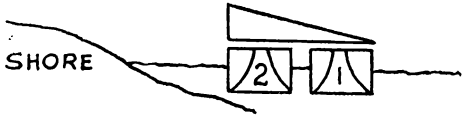
(*f*) Connect the last four panels to those of the second bay and place transoms from No. 3 pier behind the front verticals and in front of the rear verticals, loosely clamped. Fix four female connecting posts, and place transom from No. 3 pier through the posts. Connect rakers loosely. Boom out until lugs under the connecting posts are astride the gunwale of No. 3 pier. Fit sway brace and bracing frames in third bay.

(*g*) Fix all centre transoms, working from inshore outwards, tightening bracing of each bay as soon as transoms are fixed. Deck down from inshore outwards.

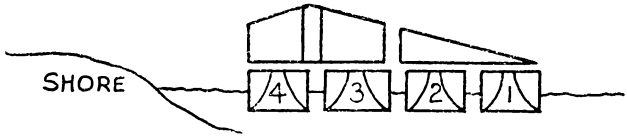
3. Landing bay pier and end floating bay

(*a*) The end floating bay, Class 70, being double single, is difficult to lift on to the landing bay transom when completed. Construction in this case is therefore started from the hook posts, and the whole raft is turned for the launching of the home bank landing bay ; it will not of course need turning for the far landing bay.

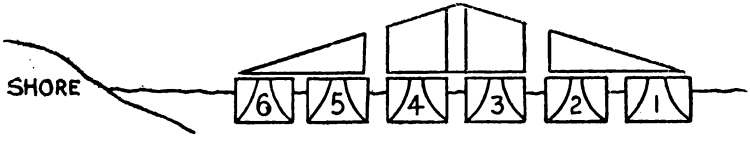
Bring alongside two tripartite piers, and connect them together with two distributing girders triangular sections, taking care not to tighten down the riband bolts holding the girders to the pontoons. Cast anchors from the offshore pier 40 ft. out from the bank, or make fast with breastlines.



(*b*) Bring inshore of piers Nos. 1 and 2 two further piers, and connect them together by means of the two gable-shaped distributing girder centre sections, again leaving the riband bolts loose.



(*c*) Bring inshore of these four piers two further tripartite piers and connect them on the upstream side only by means of a distributing girder end section, leaving the riband bolts slack and the other distributing girder end section on its side on the downstream bow sections.



(*d*) Connect the three girder sections together by means of panels pins at their bottom joints and insert split pins.

(*e*) Carry on board the landing bay transom panel, two hornbeam ends, panel saddle, and two hornbeam saddles, and lay them down on the centre sections of Nos. 5 and 6 piers. Lift the transom panel to a vertical position, and support the bottom chord of the panel (the chord with transom positions) on three chesses across the gap between Nos. 3 and 4 piers. Lifting each hornbeam section in turn, pass

them through the centre sections of the distributing girders, and connect them to the transom panel by means of the special *short* panel pins at the bottom joints, and normal pins at the top joints. Lifting one end of the transom, withdraw two of the chesses under the transom and lower that end down on to its seating in the distributing girder centre section, and insert the top pin.

Lifting the other end withdraw the remaining chess and lower that end on to its seating, insert the top pin.

Fix the panel saddle and the two hornbeam saddles. Withdraw the hook post retaining pins from the hornbeam saddles, and place on the deck of the bow section up and down stream of No. 3 pier.

(*f*) Carry on board, and place on the deck of bow sections of Nos. 1 and 2 piers, the distributing girder stiffener assembly.

(*g*) Bring inshore of these six piers one further tripartite pier. Carry thirteen transoms on board, placing :—

3 transoms on No. 4 pier downstream bow section.
2 transoms on No. 5 pier downstream bow section.
3 transoms on No. 6 pier downstream bow section.
5 transoms on No. 4 pier downstream bow section.

(*h*) Carry on board four end floating bay hook posts (female), and place them with the hook seating on the landing bay transom hornbeam saddles. Pass the retainer pin through, and lock the catches on the distributing girder centre section.

(*j*) Bring on four panels *male* jaws offshore, and connect to the hook posts. Position the piers so that the bottom chords of all four panels sit on the curved bearings. Position one transom from No. 4 pier behind the front verticals of the panels and fix transoms clamps. Pass a further transom from No. 5 pier through in front of the rear verticals, and clamp into position. Place two rakers on the first transom ; add bracing frames and sway brace to this bay. Leave bracing loose.

(*k*) Bring on four further panels and connect to the 1st bay. Pass one transom from No. 5 pier behind the front verticals, and one from No. 6 pier in front of the rear verticals, and clamp down. Add two rakers to the first transom in the second bay ; add bracing frames and sway brace, leave bracing loose.

(*l*) Bring on four further panels and connect by means of the top pins only. Pass one transom from No. 7 pier through behind the front verticals.

(*m*) Fix connecting posts (male) to the inshore ends of all four panels, and, lifting on the inshore ends of the panels, walk No. 7 pier inshore until the connecting posts are correctly positioned on the inshore gunwale. Pass a transom from

No. 7 pier in front of the rear verticals, and a further transom from No. 7 pier through the connecting posts.

Add two rakers to the first transom of the third bay, and a further two rakers to the transom in the connecting posts. Add bracing frames and sway braces and leave loose.

(*n*) Bearing down on the inshore ends of the panels of the third bay, put in the bottom pins.

(*o*) Pass two further transoms from No. 4 pier through the distributing girders, and position either side of mid-vertical of panels of first bay. Clamp down and tighten bracing. Repeat with transoms from Nos. 6 and 7 pier for each bay in turn. Fix remaining distributing girder end section.

(*p*) Make up the stiffening girder assembly, and connect the trusses to the top chords of each distributing girder. Do not tighten the bolts. Force home the bottom ends of the struts and fix them in position by means of riband bolts. Tighten all bolts.

(*q*) Begin decking from the transom in the connecting posts, and deck all three bays.

(*r*) If the current is strong, Nos. 1 and 2 piers may be introduced after the landing bay has been completed, but before decking down. In exceptionally strong currents Nos. 1 and 2 piers and Nos. 5 and 6 piers may be left out till construction is completed. Three further transoms must then be added to No. 7 pier, so that there will be only two transoms on No. 6 pier and none on No. 5 pier when they are being positioned. The end floating bay will then be decked after all connections of the landing bay pier distributing girders and the stiffener assembly have been completed.

SECTION 53.—WORKING PARTIES AND TIMES

1. Parties required for the construction of the Class 70 bridge will be the same as laid down for Class 40, with the addition of two bracing frame men to each of sections 1 and 2, of the construction parties for the floating portion of the bridge.

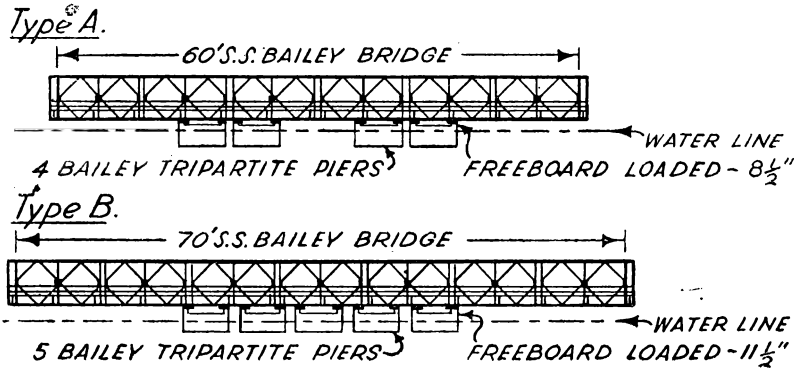
2. The following times of construction for the floating portion of the bridge do not include off loading stores and floating pontoons:

32 ft. floating bay: 55 minutes by day, 80 minutes by night.

31 ft. 6 ins. end floating bay: 70 minutes by day 100 minutes by night.

PLATE XV

40 TON BAILEY SHORE LOADING RAFTS



CHAPTER 13

BAILEY CLASS 40 RAFTS

SECTION 54.—GENERAL

1. Two types of shore loading rafts of Class 40 capacity have been designed using Bailey superstructure and tripartite pontoon piers. Type B is preferable in a strong wind or current, because it has a larger freeboard, also the inshore pontoon pier of type B does not come so close inshore. Each type is described below :—

(*a*) Type A raft consists of 60-ft. single-single bridge with Class 40 decking placed across four tripartite piers. The pontoon piers are arranged in pairs, with the handrails lashed together, so that the bearings on the centre sections are correctly aligned. The pairs of piers are placed so that their centres are 10 ft. on each side of the centre of the raft. The bridge trusses are racked down to the pontoon handrails with racking chains, if these are available, or lashed if they are not. Connecting posts are placed at each end of each truss with a transom in each ; the remaining transoms are placed behind and in front of verticals in alternate halves with double transoms at the centre. The gap in the decking between the double transoms is spanned by junction chesses. The launching link Mk. II can be inserted in the top or bottom chord 10-ft. from each end of the raft. When the launching

link is fitted transoms are placed in front of verticals in all except the inshore bay. One transom is also positioned on each launching link. Decking arrangement is illustrated at Fig. 13. The bankseat height for which the raft can be used is increased in this manner. Range of bankseat heights and freeboards are given at Table 8.

(*b*) Type B raft consists of 70-ft. single-single bridge with class 40 decking, using five tripartite piers. All five piers are lashed together with their handrails touching and correctly aligned. They are placed centrally under the bridge and the trusses are racked down to the handrails. Connecting posts are fitted to each end of each truss, the decking arrangement being as for type A rafts with double transoms 30 ft. from one end. Launching links, Mk. II, can be inserted either 10 ft. or 20 ft. from each end of the trusses. Arrangement of transoms and decking, when the launching link is used, is the same as for type A. Range of bankseat heights and freeboards are given at Table 8.

TABLE 8

Bankseat ranges : Types A and B Class 40 rafts

Raft		Freeboard unloaded	Freeboard loaded	Max. height bankseat	Min. height bankseat
Type A	No link	1 ft. 4½ ins.	8½ ins.	1 ft. 9 ins.	2 ins. below water level.
	Link 10 ft. back	1 ft. 4½ ins.	8½ ins.	2 ft. 10 ins.	11½ ins.
Type B	No link	1 ft. 11 ins.	11½ ins.	2 ft. 7 ins.	8 ins. below water level.
	Link 10 ft. back	1 ft. 11 ins.	11½ ins.	3 ft. 8½ ins.	5½ ins.
	Link 20 ft. back	1 ft. 11 ins.	11½ ins.	4 ft. 10 ins.	2 ft. 9 ins.

NOTE.—(i) Freeboard measured to top of gunwale.

(ii) Height of bankseat measured from water level to underside of panels.

(iii) Maximum and minimum heights of bankseats chosen so that freeboard is not less than 3 ins.

DECKING ARRANGEMENT AT LAUNCHING LINKS.

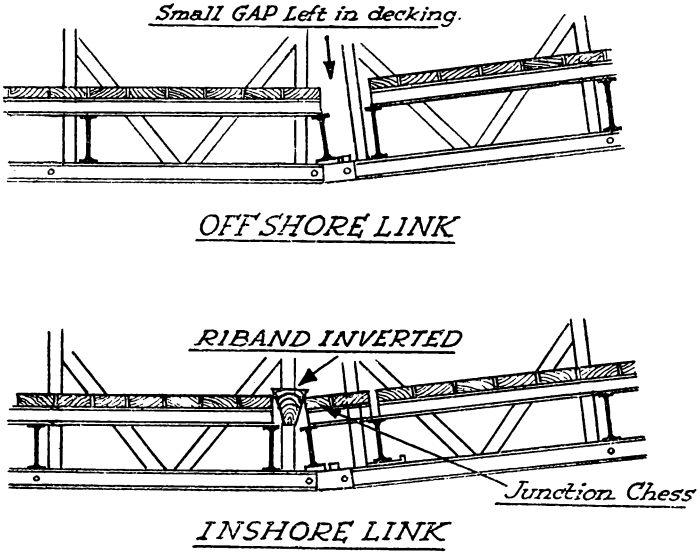


FIG. 13

SECTION 55.—METHOD OF CONSTRUCTION

1. A satisfactory method of constructing these rafts is to build the superstructure as a normal bridge on rollers on the bank, and launch it on to the offshore pontoon pier, which should be anchored ; the remaining piers are then warped into the correct position as the bridge is boomed out. Decking is added after the launch is complete.

This method can be employed on most building sites if the following points are noted :—

(*a*) Where the bank is low the launching rollers must be packed up in order to bring the tip of the span over the first pier.

(*b*) Where the banks are such that the launching rollers are higher than the pontoon, then the bottom pins should be left out between the last and the next to the last bays of the bridge ; the last panel can then pivot about the top pin, and the bridge be lowered down on to the pontoons. Preventer tackles must be used to control the superstructure during the launch.

2. Alternatively, construction can be carried out directly on the piers ; in this event the method varies for Types "A" and "B" rafts.

(*a*) *Type " A " raft.*—Bring Nos. 1 and 2 piers alongside and parallel to the bank, No. 1 being offshore. Make fast No. 1 pier with breastlines or up and downstream anchors.

Construct the first bay of superstructure as for a Class 40 floating bay, but position it with the connecting post a few inches outside the offshore gunwale. Add the second and third bays, again with transom in front of verticals, and fix sway braces and rakers. Boom out the superstructure and No. 1 pier until the offshore handrail of No. 2 pier is beneath the junction of the second and third bays.

Bring No. 3 pier inshore of the existing ones, and add the panels of the fourth bay, fixing the top pins first, and bearing down on the inshore end to fix the bottom pins. Transoms in this and succeeding bays are *behind* verticals ; sway braces and rakers therefore are fixed after the transoms of the next bay are in position. There will be double transoms at the junction of the third and fourth bays. Boom out the superstructure and Nos. 1 and 2 piers until the inshore handrail of No. 3 pier is beneath the inshore pinholes of the fourth bay.

Bring in No. 4 pier, and add the panels of the fifth bay. Lash the handrails of Nos. 3 and 4 piers together. Add the last bay of superstructure and position the connecting posts ; pass a transom through the posts and add rakers. Deck down the two inshore bays. Then move party on to No. 1 pier, and walk it into position alongside No. 2 lashing the handrails together. Deck down the remaining bays and fix three junction chesses between the third and fourth bays.

(*b*) *Type " B " raft.*—Moor Nos. 1, 2, and 3 tripartite piers alongside the bank (No. 1 offshore) and build the first three bays of superstructure as for type " A " raft. Lash the handrails of Nos. 2 and 3 piers and boom out the superstructure and No. 1 pier until the inshore ends of the panels of the third bay are in the centre of No. 3 pier.

Bring No. 4 pier inshore of the existing ones, and add the fourth bay of superstructure. Lash the handrails of Nos. 3 and 4 piers and boom out the superstructure and No. 1 pier until the centre vertical of the fourth bay is in the centre of No. 3 pier.

Bring in No. 5 pier, and add the fifth, sixth, and seventh bays of superstructure ; lash the handrails of Nos. 4 and 5 piers, and boom out the whole structure as necessary.

Deck down the three inshore bays ; move the party on to No. 1 pier, walk it into position alongside No. 2, and lash the handrails. Complete the decking down of the remaining bays.

In this raft double transoms will be at the junction

of the fourth and fifth bays, the transoms in the fifth, sixth, and seventh bays being placed behind verticals.

3. For successful and speedy loading and off loading of vehicles with the raft the following preparation should be carried out at each bank :—

(*a*) A suitable bankseat must be prepared on each shore, cut square, so that the connecting posts of the raft will bear evenly on suitable grillage. A vertical face must be provided to the back of the bankseat, with a timber end dam, against which the raft will butt when brought into shore.

(*b*) A uniformly sloping ramp of 1 in 7 or better 1 in 10 maximum gradient must be made down to the bankseat by bulldozer or other means. This should be surfaced (*e.g.*, sleepers), and should finish 2 ft. above the level of the grillage. There will then be a step down on to the deck of the raft, which will prevent damage to the end chesses.

(*c*) Holdfasts or anchorages, suitable for the type of ground, must be positioned alongside the bankseat. Preventer tackles are fixed to these, and to the end panels of the raft, by means of a strop, to hold in the raft during loading and unloading.

(*d*) Two steel cables should be provided for ferrying, one upstream, and one downstream of the centre line. These must be anchored to each bank, and should have blocks and tackles incorporated for adjustments. The raft is attached to the wire ropes by reins, made fast at one end to the bollards on the pontoon, and at the other to snatch blocks which travel along the ropes. If, however, conditions are such that both wind and current are light, 3-in. cordage cables through leading blocks on the ends of the piers will be sufficient.

SECTION 56.—METHOD OF OPERATING RAFTS

The capacity of each raft is about 10 to 15 vehicles per hour, according to the width of the river, and the conditions prevailing at the time. This speed can only be achieved and maintained if the correct methods of loading, offloading, and operating the raft are understood by all ranks. Operation of the raft is the responsibility of the R.E., under the raft commander. Control and movement of vehicles is the responsibility of the unit traffic control officer, acting under instructions from the raft commander.

The operating crew required will be as follows :—

(*a*) On raft : Raft commander and 14 men ; these are divided—

One to each chock—4 men.
One to each engine—2 men.
One to each prop unit—2 men.

One to each strop—2 men.
Four spare men—one on each rein unless otherwise required.

(*b*) On each bank—1 N.C.O. and 6 men.
To guide superstructure on to bankseat—2 men.
To connect tackles—2 men.
On running end of tackles—2 men.

Therefore two sections of an R.E. platoon are needed.

Any spare men will be required to assist in pushing off should the raft ground, or for hand hauling if the propulsion units fail. The unit traffic control officer also travels with the raft.

If mechanical means of propulsion are used, this can take the form of two or four propulsion units on the raft, according to the conditions, or towing by a lorry or tank with a 2½-in. S.W.R. attached to the superstructure at each end of the raft. Hand hauling is very slow and fatiguing, but hand hauling cables should be provided in cases of mechanical breakdown.

The following points should be noted in connection with the general operation of rafts :—

(*a*) Complete silence must be maintained by all except the R.E. raft commander and unit traffic control officer.

(*b*) All personnel must keep clear of raft decking during loading and unloading.

(*c*) Before a vehicle is brought on to the raft, or is moved to trim the raft, chocks must be placed on the decking in the position where the vehicle is required to stop.

(*d*) When loading, the tackles are loosened as soon as the vehicle is fully on the raft, but not cast off until ordered by the raft commander.

(*e*) Vehicles must be driven on and off at a steady pace in low gear, and must not slew whilst on the raft.

(*f*) Engines of all vehicles must be kept running whilst afloat.

(*g*) A.F.Vs. must be fully opened up whilst crossing.

(*h*) Responsibilities of R.E. commander :—
He is at all times in command of rafting operations.
He gives instructions to the unit officer when a vehicle is to move on or off the raft, or when it is necessary to adjust the position of a vehicle to trim the raft.
He is in charge of R.E. personnel.

(*i*) Responsibilities of the unit traffic control officer :—
He is responsible for the movement of his vehicles, as instructed by the R.E. officer.
He is in charge of all personnel of his unit on the raft.

CHAPTER 14

MAINTENANCE AND REPAIR OF DAMAGE

SECTION 57.—MAINTENANCE

1. The maintenance party required on a Bailey pontoon bridge should not be less than two sections of a field company platoon. This party must be capable of forming cut when necessary, launching pontoons, and building new floating bays. A smaller party than is normally used for construction will be sufficient, as floating spares will usually be ready on or near the site for immediate repairs.

2. In addition to the tasks laid down for maintenance of fixed span bridges, which will apply equally to the superstructure of the floating bridges, the following points must be carefully watched by the maintenance party.

(*a*) Inspect all pontoons regularly for leaking, and pump dry as required.

(*b*) Check that anchors are not dragging, and replace if necessary.

(*c*) Check riband bolts on landing bay piers, and on middle pier of Class 70 rafts.

(*d*) Grease or oil the bearings on the landing bay transom. A grease nipple is provided for the sliding bearing on the nose of the landing bay hook post.

(*e*) The panel pins in the connecting jaws of the connecting posts should be oiled regularly.

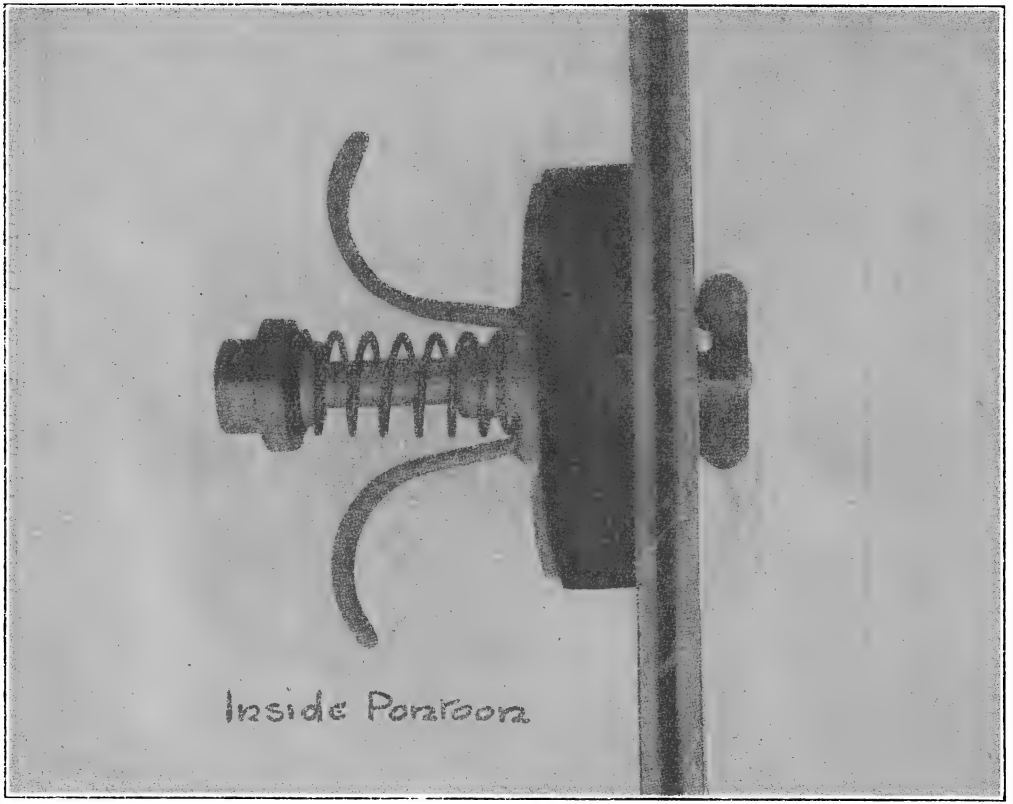
(*f*) Sentries should be stationed on the bridge to prevent damage from floating debris ; it may be necessary to erect a boom on the upstream side in times of flood, or where the enemy is able to employ floating mines against the bridge.

SECTION 58.—REPAIR OF DAMAGED PARTS

1. **Pontoons.**—Holes not greater than 1½ ins. in diameter can be repaired without moving the pontoon from the bridge by means of the spring patch illustrated at Plate XVI, which is fixed from inside the pontoon. In worse cases than these, it is a simple matter to replace the complete pontoon. After removal of the damaged pontoon the bridge superstructure will remain coupled to the next bay by means of the connecting posts, and the new pontoon pier can be inserted by loading it up (*e.g.* by filling a compartment with water, to be pumped out again afterwards) and sliding it into position.

2. **Superstructure**

(*a*) *Landing bay.*—Assessment of the importance of damage to the landing bays of a B.P.B. by aircraft or shellfire can



PONTOON PATCH

be made in the same way as is laid down for fixed span bridges in Chapter 9. Repairs can also be undertaken using the method already described. Care must be taken, however, not to increase the weight of the landing bay beyond the maximum allowable for the type of landing bay pier in use. The maximum allowable weight is given in Table 9 below, where L is the live load class.

TABLE 9

Maximum weight of landing bay for different types of landing bay pier

Types of landing bay pier	Maximum weight of landing bay Tons
4 pier raft	75 — L
6 pier raft	110 — L

It should be noted that, with Classes 60 and 70, the actual weight of the maximum span of landing bay is such that spare buoyancy is available on the landing bay pier. These bays can therefore be strengthened by the addition of parts. For Classes 40 and 50 on 6 pier rafts, however, there is no margin, and only landing bays shorter than the maximum can be strengthened.

(*b*) *Floating bays.*—Assessment of the effect of damage on the strength of a floating bay can be obtained from Plate XXXIVA by considering the superstructure of each floating bay as a fixed span between connecting posts. If the damage is such that repairs are necessary, the speediest method will be to replace the floating bay complete ; the damaged bay can then be stripped, and a new panel fitted. This bay then becomes a floating spare.

(*c*) *Floating bays with no floating spares available.*

(i) When the damage is to one of the centre panels of the bay repairs can be effected as follows : If the damage is to the top chord of the panels, supplementary chords can be added for the full length of the bay ; if the damage is to any other part of the panel, one additional truss can be added to the inner truss, or to the inner and second trusses of bridges over Class 40, for the full length of the bay, provided $\frac{3}{4}$ in. timber packing is inserted in the gunwale bearings of the inner and second trusses of bridges over Class 40. The additional truss can be fixed in the same way as for a fixed span bridge by weighting the pontoon piers sufficiently to enable the bottom chord of the panels to pass between the transoms and the gunwale.

(ii) When the damage occurs to the end panels of the bay, the complete panel must be replaced, and the connecting posts refitted. This work can readily be done if the bay is floated a few feet up or downstream of the centre line of the bridge, and the centre bay is temporarily supported on a pontoon pier.

(*d*) *End floating bay*.—If damage occurs to either of the end floating bays of the bridge, the damaged part must be replaced by a new one. Repair by addition of parts is not possible.

CHAPTER 15

PROVISION OF EQUIPMENT FOR FIXED AND FLOATING BRIDGES

SECTION 59.—TRANSPORT LOADING

The Bailey equipment has been so designed that it can all be fitted into standard 3-ton G.S. lorries, the various components being grouped together in lorry loads to form standard units. Special lorries are required to carry the pontoons for the floating bridge. The different units so formed are given below for fixed span and floating bridges.

(*a*) Fixed span bridges.
Panel lorry.
Decking lorry.
Ramp lorry.
Accessory lorry.
Grillage lorry.

(*b*) Floating bridges.
Bow pontoon lorry.
Centre pontoon lorry.
Landing bay lorries (Class 40 and 70).
Propulsion and fire fighting lorry.
Motor tug trailer.

(*c*) Combinations of the above units containing all parts for bridges of different load classes and spans have been grouped together into standard platoons as below :—

(i) The Bailey platoon carries all the necessary equipment for the erection of Class 40 fixed span bridges.

(ii) The heavy Bailey increment of the heavy bridging platoon, carrying principally transoms and panels, is provided for the conversion of Class 40 bridges to Class 70.

(iii) The pontoon platoon carries pontoons and special parts for use in conjunction with equipment from Bailey platoons, to form floating bridges.

(iv) The heavy pontoon increment of the heavy bridging platoon carries extra pontoons and special parts for the conversion of Class 40 floating bridges to Class 70.

The actual composition of the above platoons is still subject to revision and may be so for some time. Details of the loadings are not therefore given here, but will be issued separately.

SECTION 60.—CARRIAGE IN THE FIELD

All the above equipment is carried in the field by the bridge company R.A.S.C. The contents of each platoon will be fixed, but the number of platoons in a bridge company will be a variable quantity, up to a normal maximum of ten, as determined by a general staff appreciation. This will depend on a number of factors such as the types of obstacles expected, the rate of advance, and the number of routes required, etc.

SECTION 61.—CALCULATIONS OF EQUIPMENT REQUIRED AND SPARE EQUIPMENT TO BE LEFT ON SITES

1. The equipment required for any bridging operation will have been forecast from intelligence sources, and this equipment will be with the formation concerned before any detailed reconnaissance of the site can be carried out. As soon as detailed information is available from reconnaissances, allotments of equipment must be checked.

2. **Spare equipment for fixed span bridges.**—For each bridging operation the stores required for the construction of the bridge will be unloaded at the site. On completion of the bridge the equipment used in the construction of the launching nose, and all the ancillary stores used in erection will be left on the site, for the immediate use of the maintenance party on the bridge.

3. With floating bridges, spares for the superstructure will be provided in exactly the same way as described in para. (2) above, but 30 per cent. of floating spares must be allowed for in the allotment of equipment.

4. Maintenance, which in the first stages must be organized by routes, will be changed over as early as possible on to a lateral basis by river lines. Maintenance parties and stores will then be centralized and equipment surplus to requirements will be returned into circulation.

APPENDIX A

WEIGHTS IN TONS PER BAY OF VARIOUS FORMS OF BRIDGE

Construction	Class 40 Decking	Class 70 Decking
S.S.	1·92	
D.S.	2·49	2·90
T.S.	3·02	3·43
D.D.	3·59	4·00
T.D.	4·66	5·07
D.T. with overhead bracing	5·09	5·50
T.T. with overhead bracing	6·71	7·12
D.T. underslung	4·96	5·37
T.T. underslung	6·58	6·99

Single single skeleton nose	0·75 tons/bay
Double single skeleton nose	1·33 tons/bay
Triple single skeleton nose	1·85 tons/bay
Double double skeleton nose	2·43 tons/bay
Bay of decking (ribands, chesses and footwalks)	0·52 tons/bay
Conversion of Class 40 to Class 70 decking (two transoms and six clamps) ...	0·41 tons/bay
Bay of stringers	0·41 tons/bay
Bay of footwalks (complete)	0·14 tons/bay

MAXIMUM REACTION ON ANY ONE BASEPLATE

Load Class	Maximum Baseplate Reaction in Tons for Spans in Feet																						
	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	
Construction	S.S.							D.S.						T.S.		D.D.	T.D.		D.T.				T T.
9	6·8	7·6	8·3	9·0	9·6	10·1	10·9	13·2	14·3	15·6	16·4	17·3	18 2	21·0	21 8	26 1	32·4	34·0	37·5	39·1	40 8	51 6	
12	8·1	8·8	9·5	10·2	10·8	11 3	13·2	14·5	15·8	17 2	17 9	18·9	21·6	22 5	26 1	27 8	34 2	37·8	39·5	41 2	51·8	—	
18	11·7	12·5	13·3	14·0	15·4	16·2	17·0	18·7	20·2	25·2	26·5	28 0	33·5	35·0	36·7	38 5	42·2	44·3	54·4	—	—	—	
24	14·2	15·2	16·0	16·7	18·2	18·9	19·7	21·7	23 7	26·8	28·4	30·0	33 7	39·2	40 9	44 4	46·9	49·1	60·4	—	—	—	
30	16 7	17·7	18·6	19·7	20·6	21·4	22 3	24·5	27·9	29·9	33·8	35·6	41 1	42·9	46·2	48·4	51·1	61·2	—	—	—	—	
40	20·8	22·2	23·3	24·2	25 1	25·9	27 7	30·8	33·3	37·6	39·9	45 4	47·6	51·2	53 I	55·6	65 7	—	—	—	—	—	
50	25·8	27·3	28·6	29·8	31 4	32·5	33·9	39·0	42·2	48·2	51 1	55 1	57 7	60·3	68·8	72 0	—	—	—	—	—	—	
60	30·2	31·9	33 3	35·0	36·2	37·4	40·4	44·4	50·8	54·4	58·9	67·1	70·2	73·4	—	—	—	—	—	—	—	—	
70	34·6	36·5	38·3	39·7	41·0	43 6	45·3	52 1	56·5	61 8	70·1	73·9	77 2	—	—	—	—	—	—	—	—	—	
Construction	D.S.		T.S.			D.D.		T.D.		D.T.	T.T.												

SAFE BEARING PRESSURE ON GROUND

Marshy ground	0·4 tons sq. ft.
Alluvial earth, loam or silt	1·0 ,,
Mixed sand and clay	2·0 ,,
Fine sand	2·5 ,,
Coarse sand and gravel	3·5 ,,
Solid clay	4·0 ,,
Compact gravel or chalk	6·0 ,,

Type	Description	Max. load W	Effective area A	Depth below baseplate	Remarks
—	Baseplate only	Tons —	Sq. ft. 13·35	Ins. —	Load depends only on bearing pressure on ground.
F1	4 No. 9 in. × 4 in. × 6 ft. under baseplate ... ... 3 No. 9 in. × 4 in. × 6 ft. under rocking roller	45	18	3	For spans over 90 ft. (up to Class 40) and over 70 ft. (Classes 50–70) a double layer of 9 in. × 4 in. must be used under the rocking rollers on the construction side. Landing roller may have single layer of 3 No. 9 in. × 4 in. × 6 ft. only.
F2	12 No. 9 in. × 4 in. × 6 ft. under baseplate 5 No. 9 in. × 4 in. × 6 ft. under rocking roller (each in two layers).	45	36	6	
G1	14 No. 9 in. × 4 in. × 12 ft. on edge	58	39	9	
G2	14 No. 9 in. × 4 in. × 12 ft. on edge on layer of 16 No. 9 in. × 4 in. × 6 ft. on flat.	58	50	14	
G3	3 No. ramp sections on chesses	58	39	7	May be used as an alternative to type G1.
G4	3 No. ramp sections on 14 No. 9 in. × 4 in. × 8 ft. on flat.	58	52	9	May be used as an alternative to type G2.
H	9 No. 9 in. × 4 in. × 8 ft. on edge under baseplate and 6 No. 9 in. × 4 in. × 4 ft. on edge under rocking roller all on 24 No. 9 in. × 4 in. × 12 ft. on edge.	95	67	18	

Additional timber will usually be required under rocking rollers to increase their height.

Construction	Allowable bearing pressure Tons/sq. ft.		TYPE OF GRILLAGE FOR SPANS OF BRIDGE IN FEET																
			30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
S/S	1·0 2·0 and over	Class	**40**	30	30	24	12	12	9											
			F2	F1	F1	F1		*	*											
			No grillage.																	
D/S	1·0 2·0 2·5 3·5 and over	Class	**70**	**70**	60	50	**40**	**40**	30	30	24	12	12	12	9					
			F2 **F1** **F1**	**F2** **F1** **F1**	F2 F1	F2 F1	**F2**	**F2**	F2	F2	F2	F2 *	G1 *	G1 *	G1 *					
			No grillage.																	
T/S	1·0 2·0 2·5 3·5 and over	Class			**70**	**70**	**70**	60	50	**40**	**40**	30	24	24	12	12	9			
					G1 **F2** **F1**	**G1** **F2** **F1**	**G2** **F2** **F1**	G1 F2 F1	F2 F1	**F2** **F1**	**G1** **F1**	G1 F1	G1 F1 *	G1 F1 *	G1 * *	G1 † †	G1 † †			
			No grillage.																	
D/D	1·0 2·0 2·5 3·5 and over	Class					**70**	**70**	60	50	**40**	**40**	30	24	18	12	12			
							G2 **F2** **F1**	**G2** **F2** **F1**	G2 F2 F1	G2 F2 F1	**G1** **F2** **F1**	**G1** **F2** **F1**	G1 F2 F1†	G1 F1† F1†	G1 F1† F1†	G1 F1† †	G1 G1 †			
			No grillage.																	

NOTES.—1. * Single layer 9 ins. × 4 ins. × 6 ft. timber required under launching rollers.
2. † Double layer 9 ins. × 4 ins. × 6 ft. timber required under launching rollers.
3. Grillages types G3 and G4 can replace types G1 and G2 respectively.

Construction	Allowable bearing pressure Tons/sq. ft.		TYPE OF GRILLAGE FOR SPANS OF BRIDGE IN FEET																
			70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240
T/D		**Class**				**70**	**70**	60	50	**40**	**40**	30	24	18	12	9				
	1·0					**G2**	**G2**	G2	G2	**G2**	**G2**	G2	G2	G1	G1	G1				
	2·0					**G1**	**G1**	G1	G1	**G1**	**G1**	G1	G1	G1	G1	G1				
	2·5					**G1**	**G1**	G1	G1	**F1†**	**G1**	F1†	F1†	F1†	F1†	F1†				
	3·5					**G1**	**G1**	G1	G1	†		†	†	†	†	†				
	4·0						**G1**	G1	†	†	†	†	†	†	†	†				
	6·0					No grillage														
D/T		**Class**						**70**	60	50	50	50	**40**	**40**	30	24	12	12	9	
	1·0							**H**	H	H	H	H	**H**	**H**	G2	G2	G1	G2	G2	
	2·0 to 3·5							**H**	H	G1	H	H	**G1**	**G1**	G1	G1	G1	G1	G1	
	4·0							**H**	H	G1	H	H	†	**G1**	†	†	†	†	†	
	6·0							No grillage.												
T/T		**Class**							**70**	**70**	**70**	60	50	50	**40**	30	24	12	12	9
	1·0														**H**	H	H	—	H	H
	2·0 to 4·0								**H**	**H**	**H**	H	H	H	**H**	H	H	—	G2	G2
	6·0								No grillage											

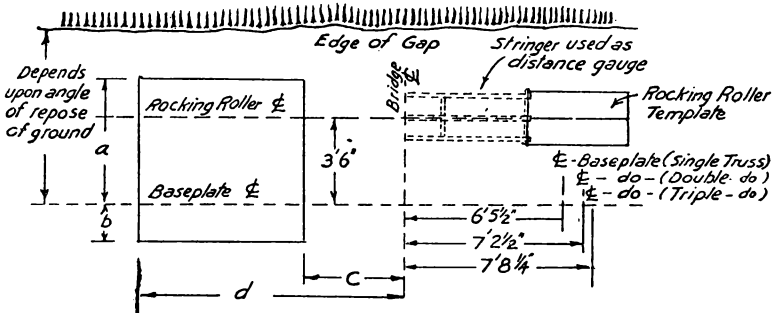
NOTES.—1. * Single layer 9 ins. × 4 ins. × 6 ft. timber required under launching rollers.

2. † Double layer 9 ins. × 4 ins. × 6 ft. timber required under launching rollers.

3. Grillages types G3 and G4 can replace types G1 and G2 respectively.

Type of grillage	Trusses in bridge	Dimensions for setting out grillage excavation				Depth of excavation to underside of grillage*				
						10-ft. ramp			20-ft. ramp	
		c	*d*	*a*	*b*	Level	1 in 20	1 in 10	1 in 20	1 in 10
Baseplate only.	S	4 ft. 0 ins.	9 ft. 0 ins.	1 ft. 9 ins.	1 ft. 9 ins.	2 ft. 4 ins.	1 ft. 10 ins.	1 ft. 4 ins.	1 ft. 4 ins.	4 ins.
	D	4 ft. 9 ins.	9 ft. 9 ins.							
	T	5 ft. 3 ins.	10 ft. 3 ins.							
F1	S	3 ft. 3 ins.	9 ft. 9 ins.	4 ft. 9 ins.	1 ft. 9 ins.	2 ft. 8 ins.	2 ft. 2 ins.	1 ft. 8 ins.	1 ft. 8 ins.	8 ins.
	D	4 ft. 0 ins.	10 ft. 6 ins.							
	T	4 ft. 6 ins.	11 ft. 0 ins.							
F2		Same as for F1		4 ft. 9 ins.	3 ft. 3 ins.	3 ft. 0 in.	2 ft. 6 ins.	2 ft. 0 in.	2 ft. 0 in.	1 ft. 0 in.
G1	D	4 ft. 8 ins.	9 ft. 10 ins.	7 ft. 6 ins.	5 ft. 0 in.	3 ft. 1 ins.	2 ft. 7 ins.	2 ft. 1 in.	2 ft. 1 in.	1 ft. 1 in.
	T	5 ft. 2 ins.	10 ft. 4 ins.							
G2	D	4 ft. 0 ins.	10 ft. 6 ins.	7 ft. 6 ins.	5 ft. 0 in.	3 ft. 5 ins.	2 ft. 11 ins.	2 ft. 5 ins.	2 ft. 5 ins.	1 tt. 5 ins.
	T	4 ft. 6 ins.	11 ft. 0 ins.							
G3	D	1 ft. 0 ins.	13 ft. 6 ins.	6 ft. 9 ins.	4 ft. 3 ins.	2 ft. 11 ins.	2 ft. 5 ins.	1 ft. 11 ins.	1 ft. 11 ins.	11 ins.
	T	1 ft. 6 ins.	14 ft. 0 ins.							
G4	D	3 ft. 0 ins.	11 ft. 6 ins.	6 ft. 9 ins.	4 ft. 3 ins.	3 ft. 1 in.	2 ft. 7 ins.	2 ft. 1 in.	2 ft. 1 in.	1 ft. 1 in.
	T	3 ft. 6 ins.	12 ft. 0 ins.							
H	D	3 ft. 0 ins.	11 ft. 6 ins.	7 ft. 6 ins.	5 ft. 0 in.	3 ft. 10 ins.	3 ft. 4 ins.	2 ft. 10 ins.	2 ft. 10 ins.	1 ft. 10 ins.
	T	3 ft. 6 ins.	12 ft. 0 ins.							
					Intermediate transom 9 ins. × 4 ins. timber.				1 ft. 2 ins.	8 ins.

Depth of excavation required at end of ramp 10 ins. in all cases, assuming support on 9 ins. × 4 ins. timber. * Ground assumed level.

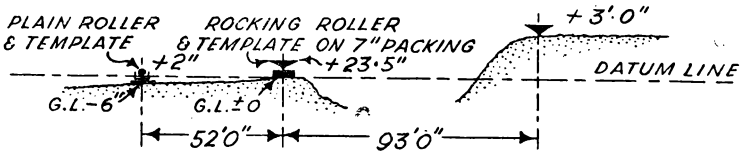


NOTE: Distance from ℄ of Baseplate to inside and rear edges of grillage shown on Type drawings.

APPENDIX F

EXAMPLE OF LAUNCHING CALCULATION

100-ft. class 40 triple-single bridge.



Data

Length of nose=six bays. Ground level at 27 ft. rollers—2 ins.

Difference in height of banks 36 ins. Ground level at 52 ft. rollers—6 ins.

Sag in bridge=22 ins. Height of plain roller on template 8 ins.

Height of rocking rollers on template=16½ ins.

It is assumed for simplicity that no grillage is required.

Calculation

Total height through which the nose must be raised is :—

Difference in banks	= 36 ins.
Sag	= 22 ins.
Allowance for error	= 6 ins.
	64 ins.

If one launching nose link is fitted two bays back from tip of nose this will lift the nose 27 ins.

Therefore remaining lift required=64—27=37 ins.

When the bridge is launched it will be resting on the launching roller and the 52-ft. plain rollers. The difference in level x between the rollers to produce a lift of 37 ins. at the tip of the nose, will therefore be found from :—

$$\frac{x}{52} = \frac{37}{93} \quad \therefore \quad x = \frac{37 \times 52}{93} = 21 \text{ ins.}$$

Height of rocking roller on template above datum level=+ 16·5 ins.

Height of plain roller on template above datum level=+ 2 ins.
(Ground level at plain roller = — 6 ins.)

Difference in heights without packing = 14·5 ins.

Amount of packing required under launching roller is therefore 7 ins.

Level of 27-ft. roller obtained by boning through between launching roller and 52-ft. roller.

Check for grounding of tail

With launching link on landing rollers the tail will be overhanging 47 ft. behind the launching rollers.

Landing roller will now be only 29 ins. higher than launching roller (allowing for 7 ins. packing).

The tail will therefore be $\frac{47 \times 29}{93}$ ins. below level of launching roller, *i.e.* 14·5 ins. below launching roller level.

As the ground is below datum level at this point, the tail will not therefore ground.

The above example has been worked out in a simple manner. Once this basic method has been understood, improvements can be adopted on the lines of the following examples :—

(1) To avoid checking back for the grounding of the tail : place the bridge, assuming no links are used, so that the tip of the nose is on the landing rollers ; place tail of bridge 6 ins. above ground level ; and calculate corresponding height of launching rollers with bridge in this position ; position links as required to take out the sag.

(2) Further to the above, when the launching plane is inclined, then in order to avoid pushing uphill all the way, the launching plane may be selected either level or at an intermediate slope, and the position of the links adjusted to compensate for this. When this method is used, greater power will be needed to clear the links over the landing rollers, but building will be easier.

NUMBER OF PARTS REQUIRED PER BAY FOR VARIOUS BRIDGES

(*a*) *Bridges up to Class* 40.

Part	End bay No. 1							Intermediate bay							End bay No. 2						
	S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.	S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.	S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.
Base plates	2	2	2	2	2	2	2	—	—	—	—	—	—	—	2	2	2	2	2	2	2
Bearings	2	4	4	4	4	4	4	—	—	—	—	—	—	—	2	4	4	4	4	4	4
Bearers, footwalk	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6	6
Bolts, bracing	4	12	16	20	28	20	20	4	12	16	20	28	28	40	8	16	20	32	40	40	44
Bolts, chord	—	—	—	8	12	8	12	—	—	—	8	12	20	28	—	—	—	8	12	8	12
Bolts, riband	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Braces, sway	2	2	2	2	2	2	2	2	2	2	2	2	4	4	2	2	2	2	2	2	2
Chesses	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Clamps, transom	4	8	12	8	12	8	12	4	8	12	8	12	8	12	4	8	12	8	12	8	12
Frames, bracing	—	2	2	4	4	4	4	—	2	2	4	4	6	6	—	2	2	6	6	8	8
Panels	2	4	6	8	12	12	18	2	4	6	8	12	12	18	2	4	6	8	12	12	18
Pins, panel	4	8	12	12	18	12	18	4	8	12	16	24	24	36	8	16	24	28	42	36	54
Posts, end, male	2	4	6	4	6	4	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Posts, end, female	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	4	6	4	6	4	6
Posts, footwalk	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6	6
Footwalks	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Rakers	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4
Ribands	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Split pins	4	8	12	12	18	12	18	4	8	12	16	24	24	36	8	16	24	28	42	36	54
Stringers, button	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Stringers, plain	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Tieplates	—	—	2	—	4	—	—	—	—	2	—	4	—	6	—	—	2	—	4	—	2
Transoms	2	2	2	2	2	3	3	2	2	2	2	2	3	3	3	3	3	3	3	4	4
Overhead bracing support.	—	—	—	—	—	2	2	—	—	—	—	—	2	2	—	—	—	—	—	2	2
(*b*) *Extra parts required for bridges over Class* 40																					
Clamps, transom	—	4	6	4	6	4	6	—	4	6	4	6	4	6	—	4	6	4	6	4	6
Transoms	—	2	2	2	2	2	2	—	2	2	2	2	2	2	—	2	2	2	2	2	2

NOTE.—End bay No. 2 has transom in end post.

APPENDIX H

PARTS REQUIRED FOR FLOATING BAY, END FLOATING BAY AND LANDING BAY PIER CLASS 40

1. Floating bays

Item	No. per 32-ft. bay	No. per 42-ft. bay	No. per 52-ft. bay
Bolts, bracing	16	20	24
Bolts, riband	24	32	40
Braces, sway	6	8	10
Chesses	39	52	65
Chesses, junctions	6	6	6
Clamps, transom	12	16	20
Guards, fingers	2	2	2
Panels	6	8	10
Pins, panel (each with 1 split pin)	18	22	26
Pontoons, centre	2	2	2
Pontoons, Mk. V or Mk. VI	4	4	4
Posts, connecting, floating bay, male	2	2	2
Posts, connecting floating bay, female	2	2	2
Rakers	8	10	12
Ribands	6	8	10
Stringers, button	6	8	10
Stringers, plain	9	12	15
Transoms	8	10	12

2. Landing bay pier and 31 ft. 6 ins. end floating bay—two each per bridge

Item	Number per landing bay pier	Number per end floating bay	Total	Remarks
Bolts, bracing	—	16	16	
Bolts, riband	12	24	36	
Braces, sway	—	6	6	
Chesses	—	39	39	
Chesses, junction	—	6	6	
Clamps, transom	—	12	12	
Girders, distributing	4	—	4	
Guards, finger	—	2	2	
Panels	—	6	6	
Pins, panel	2	18	20	Each with 1 split pin.
Pontoons, centre	4	1	5	
Pontoons, Mk. V or Mk. VI	8	2	10	Each with anchor, etc.
Posts, connecting, floating bay	—	2	2	Male.
Posts, hook, floating bay	—	2	2	
Rakers	—	8	8	
Ribands	—	6	6	
Stringers, button	—	6	6	
Stringers, plain	—	9	9	
Transoms	—	7	7	
Transoms, landing bay (complete with 2 transom pins each with 1 split pin)	1	—	1	

APPENDIX J

PARTS REQUIRED FOR FLOATING BAY, END FLOATING BAY, AND LANDING BAY PIER CLASS 70

1. 32 ft. floating bay

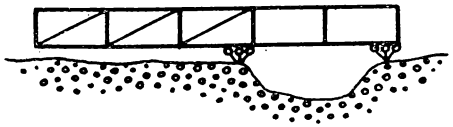
Item	Number per 32-ft. bay	Remarks
Blocks, panel anchorage	4	
Bolts, bracing	40	
Bolts, riband	28	
Braces, sway	6	
Chesses	39	
Chesses, junction	6	
Clamps, transom	36	
Frames, bracing	6	
Guards, finger	4	
Panels	12	
Pins, panel	36	Each with 1 split pin.
Pontoons, centre	3	
Pontoons, Mk. V or Mk. VI ...	6	Each with anchor, etc.
Posts, connecting, F.B., male ...	4	
Posts, connecting, F.B., female ...	4	
Rakers	8	
Ribands	6	
Stringers, button	6	
Stringers, plain	9	
Transoms	14	

2. Landing bay pier and 31 ft. 6 ins. end floating bay

Item	Number per landing bay pier	Number per end floating bay	Total	Remarks
Bolts, bracing	24	40	64	
Bolts, riband	16	24	40	
Braces, sway	—	6	6	
Chesses	—	39	39	
Chesses, junction	—	3	3	
Clamps, transom	—	36	36	
Frames, bracing	—	6	6	
Guards, finger	—	4	4	
Girders, distributing (Class 40)	4	—	4	
Girders, distributing, centre section	2	—	2	
Girders, distributing, stiffener, L.H.	2	—	2	Complete with bolt and nut.
Girders, distributing, stiffener, R.H.	2	—	2	
Girders, distributing, strut, double	2		2	Complete with 2 brackets, 4 bolts and 4 nuts.
Girders, distributing, strut, long	4	—	4	Complete with 1 bracket, 2 bolts and 2 nuts.
Girders, distributing, strut, short	4	—	4	Ditto
Panels	—	12	12	
Pins, panel	12	36	48	Each with 1 split pin.
Pontoons, centre	6	1	7	
Pontoons, Mk. V or Mk. VI	12	2	14	Each with anchor, etc.
Posts, connecting, floating bay (male)	—	4	4	
Posts, hook, floating bay ...	—	4	4	
Rakers	—	8	8	
Ribands	—	6	6	
Stringers, button	—	6	6	
Stringers, plain	—	9	9	
Transoms	—	13	13	
Transoms, L.B., Class 70—				
Centre panel	1	—	1	
Hornbeam, Type B ...	1	—	1	
Hornbeam, Type C ...	1	—	1	
Saddles, panel	1	—	1	
Saddles, Hornbeam ...	2	—	2	Complete with transom pin and split pin.

LAUNCHING DATA
SINGLE - SINGLE

PLATE
XVII A.



SPAN IN FEET	LOAD CLASS	BAYS IN NOSE	LAUNCHING WEIGHT. TONS	SAG INCHES
30	40	2	7	3
40	30	3	10	4
50	30	3	12	5½
60	24	4	15	8
70	12	5	17	11
80	12	5	19	16
90	9	6	22	24

NOTES FOR PLATES XVII A - F

① BRIDGE LAUNCHED COMPLETE EXCEPT WHERE OTHERWISE STATED.

② ROCKING ROLLERS 3FT 6INS IN FRONT OF BASEPLATE ON EACH BANK MINIMUM 2FT. 6INS.

③ WEIGHT PER BAY AS IN APPENDIX 'A'

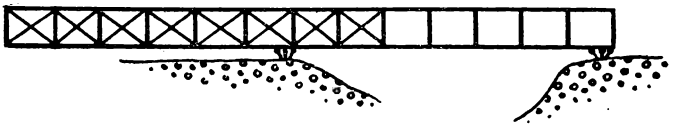
④ SAG GIVEN IS AT TIP OF LAUNCHING NOSE.

⑤ ALL BRACING MUST BE FIXED AND TIGHTENED BEFORE LAUNCHING, INCLUDING BRACING FRAMES ON D.S. NOSE AND ON ANY INCOMPLETE PART OF THE BRIDGE.

† IF FOR ANY REASON FOOTWALKS ARE OMITTED FROM THE BRIDGE DURING THE LAUNCH, UP TO 1 TON COUNTERWEIGHT MAY BE NECESSARY ON THE TAIL.

LAUNCHING DATA
DOUBLE-SINGLE

PLATE
XVII B.

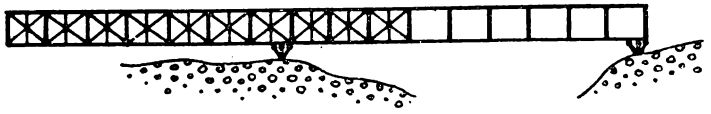


SPAN IN FEET	LOAD CLASS	BAYS IN NOSE	LAUNCHING WEIGHT. TONS	SAG INCHES
† 40*	70	2	13	2½
50*	60	3	17	4½
60*	50	4	20	7½
70	40	4	20	11
80	40	5	24	15
90	30	6	27	20
100	30	6	29	25
110	24	7	33	31
† 120	12	7	35	38
130	12	8	38	47
140	12	8	42	58
150	9	9	44	70

* CLASS 70 DECKING SYSTEM.

LAUNCHING DATA
TRIPLE SINGLE

PLATE
XVII C.,



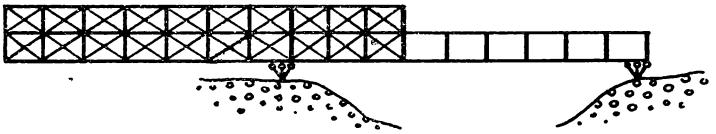
SPAN IN FEET	LOAD CLASS	BAYS IN NOSE		LAUNCHING WEIGHT. TONS	SAG INCHES
		SINGLE SINGLE	DOUBLE SINGLE		
50 *	70	3	–	19	3½
† 60 *	70	3	–	23	5½
70 *	70	4	–	27	8½
80 *	60	5	–	31	12
90 *	50	5	–	34	17
100	40	6	–	35	22
110	40	7	–	38	27
120	30	7	–	41	34
130	24	8	–	45	40
† 140	24	8	–	48	47
150	12	9	–	52	54
160	12	9	1	56	63
170	9	9	1	59	74

* CLASS 70 DECKING SYSTEM.

TOTAL LENGTH OF NOSE EQUALS SINGLE - SINGLE PLUS DOUBLE - SINGLE.

LAUNCHING DATA
DOUBLE - DOUBLE
(LAUNCHED COMPLETE)

PLATE
XVII D.



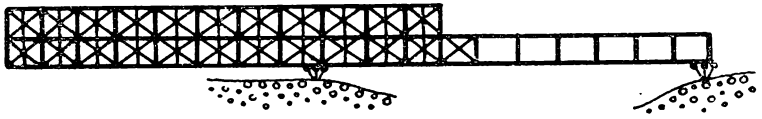
SPAN IN FEET	LOAD CLASS	BAYS IN NOSE		LAUNCHING WEIGHT. TONS	SAG INCHES
		SINGLE SINGLE	DOUBLE SINGLE		
80 *	70	5	–	36	12
90 *	70	6	–	41	14
100 *	60	6	–	45	17
110 *	50	7	–	49	21
† 120	40	7	–	48	25
130	40	8	–	53	30
140	30	8	1	58	37
† 150	24	7	2	62	43
160	18	8	2	66	50
170	12	8	2	70	58
180	12/9	8	3	75	66

* CLASS 70 DECKING SYSTEM.

TOTAL LENGTH OF LAUNCHING NOSE EQUALS SINGLE - SINGLE PLUS DOUBLE - SINGLE.

LAUNCHING DATA
TRIPLE DOUBLE
(LAUNCHED COMPLETE) EXCEPT WHERE OTHERWISE STATED.

PLATE XVII E.



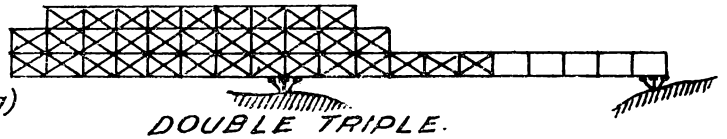
SPAN FEET	LOAD CLASS	BAYS IN NOSE			LCHG. WEIGHT	SAG INCHES	BRIDGE LAUNCHED WITHOUT :-
		S.S.	D.S.	T.S.	TONS		
100*	70	6	-	-	55	15	
110*	70	6	1	-	62	20	
120*	60	5	2	-	67.	23	
130*	50	6	2	-	73	28	
†140	40	6	2	-	72	33	
150	40	6	3	-	78	39	
160	30	6	3	-	83	45	
170⊙	24	6	4	-	80	50	CHESSES & FOOTWALKS
180⊙	18	7	4	-	84	55	CHESSES & FOOTWALKS
190⊙	12	6	4	1	84	60	FIRST 15 BAYS OF STRINGERS AND ALL CHESSES & FOOTWALKS
200⊙	9	7	4	1	84	66	FIRST 2 BAYS OF UPPER STOREY AND ALL BAYS OF STRINGERS, CHESSES & FOOTWALKS.

* CLASS 70 DECKING SYSTEM.

TOTAL LENGTH OF LAUNCHING NOSE EQUALS SINGLE-SINGLE PLUS DOUBLE-SINGLE PLUS TRIPLE-SINGLE.

⊙ PARTS LEFT OFF BRIDGE TO REDUCE WEIGHT TO 84 TONS FOR LAUNCHING.

PLATE XVII F.



(g) DOUBLE TRIPLE.

SPAN	LOAD CLASS	BAYS IN NOSE S/S	D/S	D/D	LAUNCH WT.	SAG	LAUNCH COMPLETE EXCEPT FOR
*120	70	5	2	–	69	19	
*130	60	5	2	–	75	23	
*140	50	6	2	–	81	27	
*150	50	6	3	–	84	36	8 BAYS OF CHESSES AND FOOTWALKS
*160	50	6	3	–	84	39	ALL CHESSES & FOOTWALKS
170	40	6	4	–	84	49	DITTO
180	40	6	4	1	84	56	ALL CHESSES FOOTWALKS AND STRINGERS
190	30	6	4	1	84	72	ALL CHESSES FOOTWALKS STRINGERS & 3 BAYS OF TOP STORY
200	24/16	6	4	1	84	81	ALL CHESSES FOOTWALKS STRINGERS & 5 BAYS OF TOP STORY

SPANS BELOW LAUNCHED AS D/D LESS.

210	12	6	5	1	84	114	7 BAYS OF CHESSES AND FOOTWALKS
220	12	7	5	1	84	135	14 BAYS OF CHESSES AND FOOTWALKS
230	9	7	5	2	84	151	ALL CHESSES FOOTWALKS & 4 BAYS OF STRINGERS

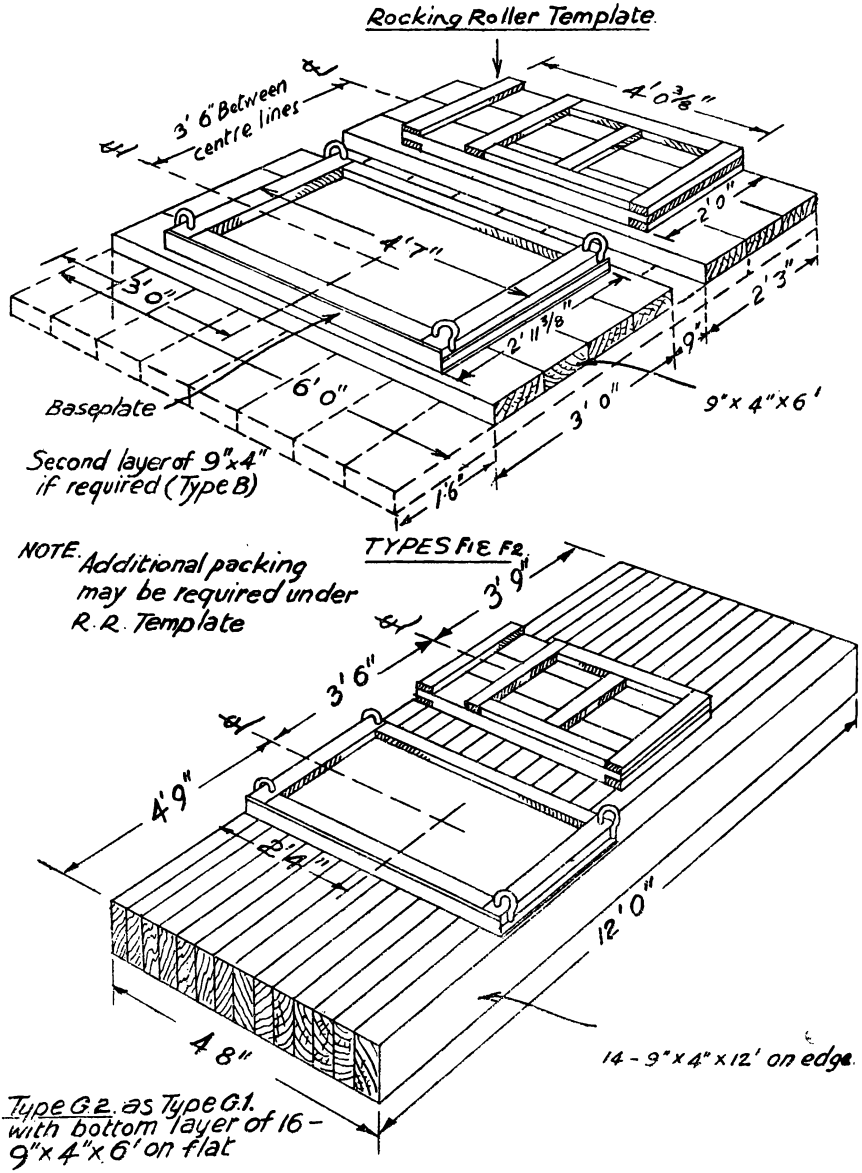
* CLASS 70 DECKING SYSTEM

TOTAL LENGTH OF LAUNCHING NOSE EQUALS SINGLE-SINGLE PLUS DOUBLE-SINGLE PLUS DOUBLE-DOUBLE

ALL TRIPLE-TRIPLE BRIDGES LAUNCHED AS TRIPLE-DOUBLE UP TO MAXIMUM OF 200FT SPAN.

PLATE XVIII

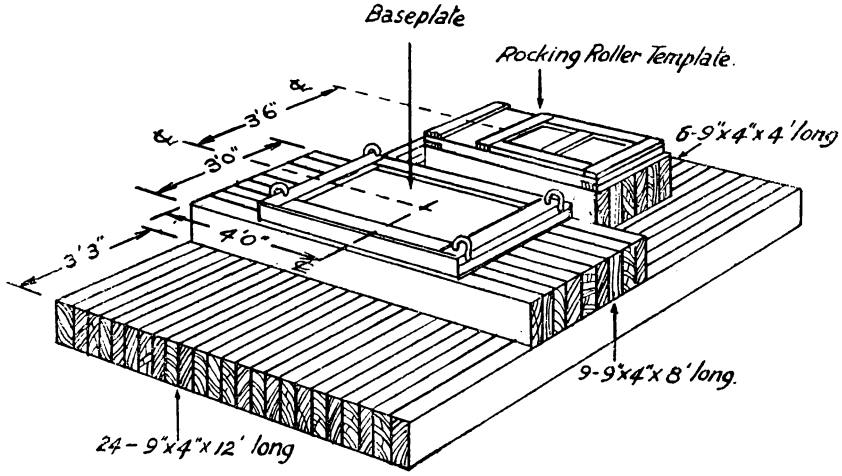
GRILLAGES FOR BAILEY BRIDGE.



TYPE. G. I.

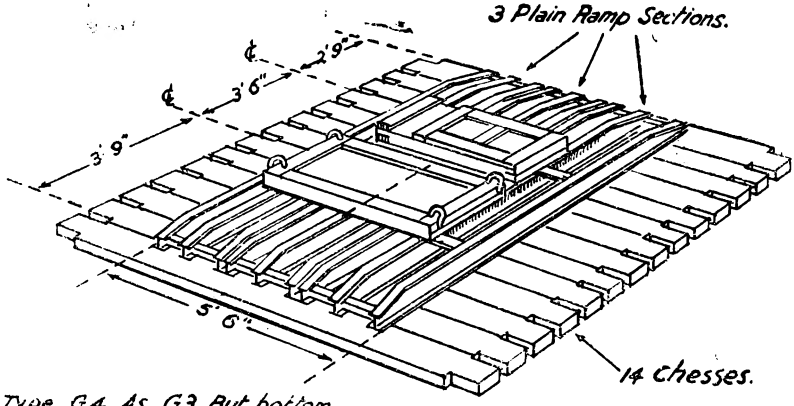
PLATE XIX

GRILLAGES FOR BAILEY BRIDGE.



TYPE. H.

NOTE Additional packing may be required under R.R. Template.



Type G.4. As G3. But bottom layer of 15-9"x4"x8'0 on flat.

TYPE G.3.

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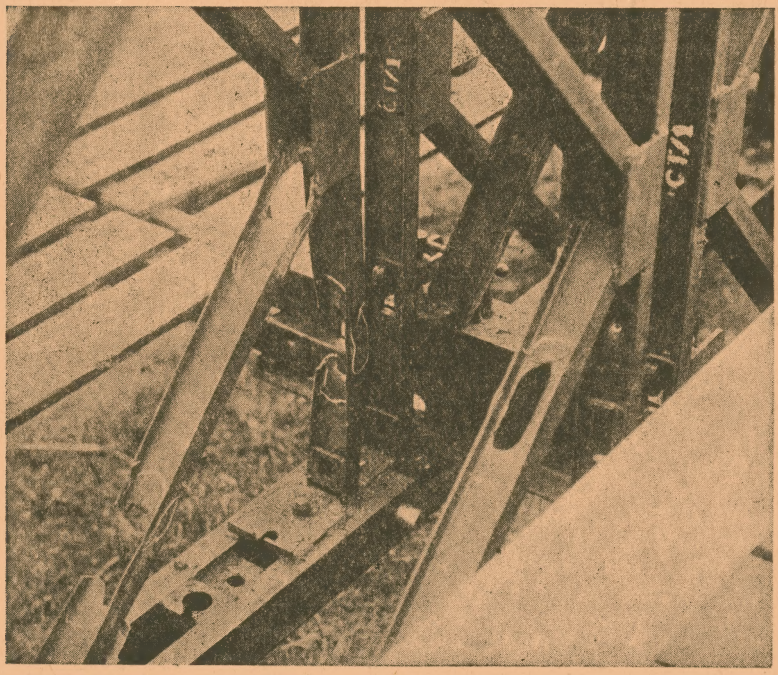
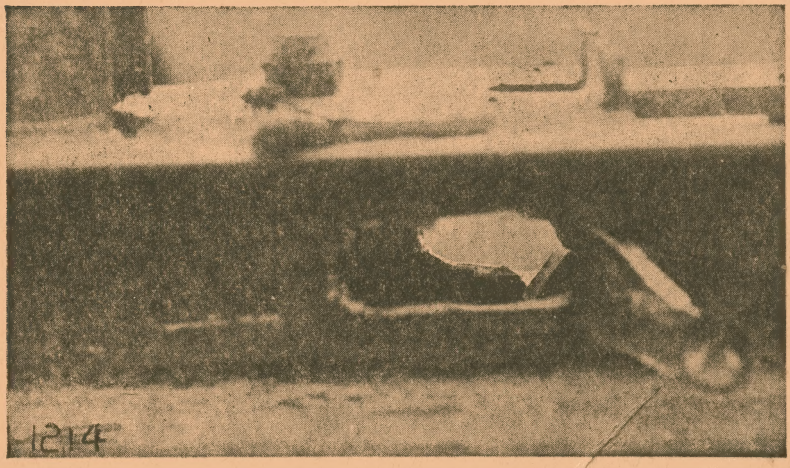
PLATE XXXV

TYPICAL DAMAGE DUE TO AIRCRAFT ATTACK



PANEL VERTICALS AND DIAGONALS



PANEL CHORD